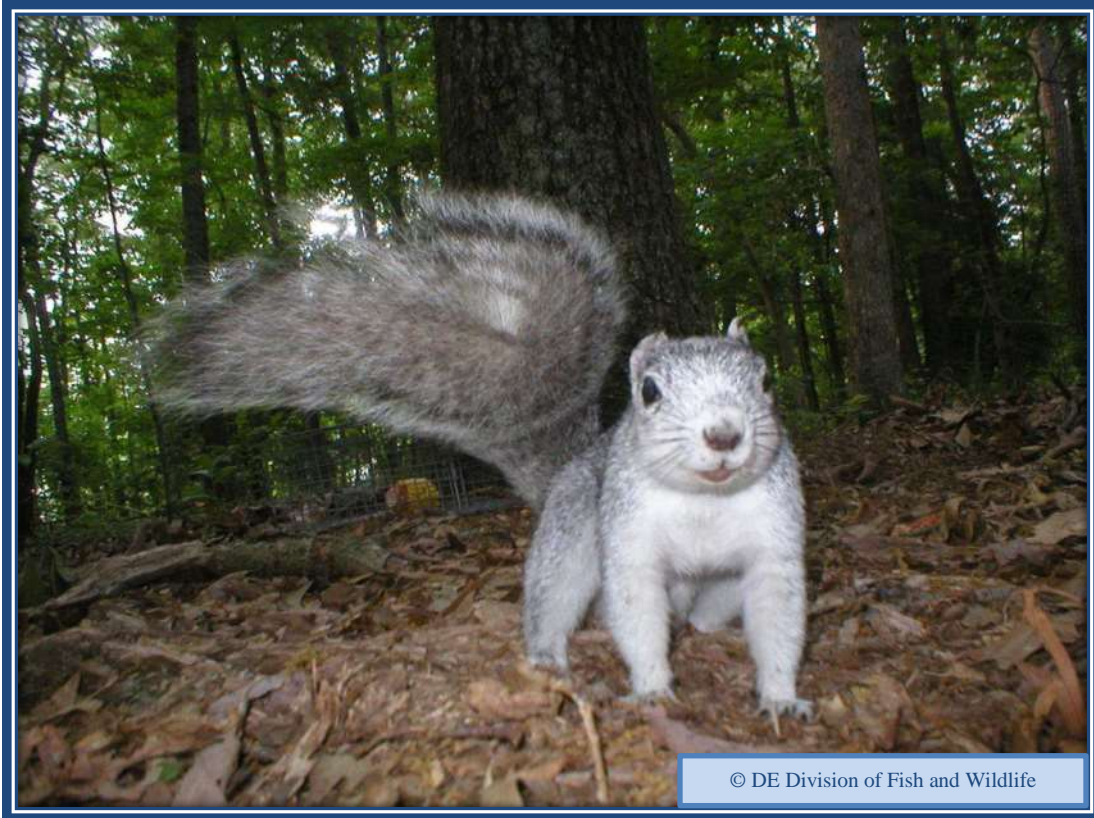


DELAWARE DELMARVA FOX SQUIRREL CONSERVATION PLAN



**DELAWARE DEPARTMENT OF NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL**

DIVISION OF FISH AND WILDLIFE

MARCH 2014



EXECUTIVE SUMMARY

The Delmarva fox squirrel (*Sciurus niger cinereus*) (DFS) is an endemic subspecies of fox squirrel that only occurs on the Delmarva Peninsula. Once found throughout the peninsula and into southeast Pennsylvania and possibly New Jersey (Taylor 1976), DFS numbers and range have been greatly reduced, likely by historic clearing of land for agriculture and short-rotation timber harvest. Over-hunting may also have affected isolated populations and contributed to this decline (USFWS 2007). In 1967, the DFS was among the first species listed as federally endangered under the Endangered Species Act (ESA). Although the species has largely recovered and is now poised to be removed from the federal list, its numbers and distribution remains low in Delaware, where it is listed as state endangered.

Although it does not symbolize the nation like the bald eagle, harbor beauty and fragility like the Karner blue butterfly or inspire awe as wolves and other large mammals can, the DFS is a Delmarva Peninsula specialty; a symbol of the geographic region it calls home. The species' large size, fluffy tail, striking silver coloration and calm demeanor were once a prominent feature of the peninsula's landscape. Maintaining this unique squirrel is important to the people of Delaware and to the ecological diversity of the area. This DFS Conservation Plan (Plan) is an opportunity and commitment to enhance populations of DFS and restore them as part of the forested landscape in Sussex County, Delaware. While the Plan focuses efforts in Sussex County, it will be applicable to any DFS that might be found or move into other counties in Delaware.

The goal of this Plan is to advance the recovery of DFS in Delaware without causing regulatory burdens often associated with endangered species. Because of challenges associated with the federal ESA, many of the actions listed in this Plan will not occur until the species is federally delisted; which is anticipated to occur before the year 2016. This Plan provides guidance and a set of actions to achieve this goal without impacting economic development or landowners. The Plan will not only benefit DFS, but its implementation will also benefit forest ecosystems that support many other wildlife species in need of conservation in Delaware, as well as other important ecological values provided by forests (increased air and water quality).

Translocation (the moving of animals from robust populations to suitable, but unoccupied habitats) has proven to be an important and effective tool for increasing the distribution of this species and is the cornerstone of this Plan. A translocation plan will be used to bring squirrels into unoccupied habitat that meets the criteria for long-term DFS population viability. The specific goals for DFS populations in Delaware are to double the distribution of squirrels by adding them to a minimum of two new locations in Sussex County, increase the occupied habitat by a minimum of 900 acres (450 acres or more per new site) and to ensure that all four populations are secure. Additional translocation sites may be considered if willing landowners with sufficient and suitable habitat are identified in the future.

The Plan also includes *DFS-Friendly Practices* for foresters, developers and public or private landowners who wish to support DFS on their property. Establishment of new populations is expected to occur over a period of four to five years, but monitoring the sites will continue

periodically for at least ten years post-translocation. Once reproduction has been documented in all four populations, some dispersal from the translocation sites has occurred and all populations are determined to be stable to increasing for ten or more years post-translocation, the state listing of the species will be reevaluated.

The Plan is a cooperative effort that engages multiple parties including the Delaware Department of Natural Resources and Environmental Control (DNREC; Divisions of Fish and Wildlife and Parks and Recreation), Delaware Department of Agriculture (Delaware Forest Service), Delaware Department of Transportation, U.S. Fish and Wildlife Service (Chesapeake Bay Field Office), Sussex County Council, private landowners and developers, several conservation organizations and others that have an interest in the species and the Plan. Actions recommended here support habitat and wildlife management planning for forested lands in Delaware's Wildlife Action Plan (Section 6) (DNREC 2006) and the Delaware Forest Service's Strategy (2010) and Resource Assessment.

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APPENDICES

Appendix A: Species of Greatest Conservation Need to Benefit from the Protection of Delmarva Fox Squirrel.

Appendix B: Draft Translocation Plan for the Delmarva Fox Squirrel in Delaware.

Appendix C: Potential Partners and Programs for Land Conservation/Delmarva Fox Squirrel Habitat Protection.

Appendix D: Summary of the Timber Volumes for Redden State Forest by Species and Age Class by Tract.

ACRONYMS

CCP	Comprehensive Conservation Plan
CPUE	Catch-per-unit-effort
DEN	Delaware Ecological Network
DNREC	Delaware Department of Natural Resources and Environmental Control
DFS	Delmarva Fox Squirrel
DFW	Division of Fish and Wildlife
ESA	Endangered Species Act (Federal)
GPS	Global Positioning System
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HSI	Habitat Suitability Index
MOU	Memorandum of Understanding
NOAA	National Oceanic Atmospheric Administration
NGO	Non-governmental Organization
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
OPSC	Office of State Planning Coordination
PLUS	Preliminary Land Use Service
PVA	Population Viability Analysis
SGCN	Species of Greatest Conservation Need
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WA	Wildlife Area

PURPOSE OF THIS DFS CONSERVATION PLAN

The purpose of this Delmarva Fox Squirrel Conservation Plan (Plan) is to provide a framework for conservation actions to increase and sustain Delmarva fox squirrel (*Sciurus niger cinereus*), (DFS) populations in Sussex County, Delaware and help secure their status range-wide, while addressing the needs of non-wildlife related land uses. Recovery of the species in the state will benefit both the long-term survival of the species and provide the public with the ability to enjoy these squirrels. The Plan has been developed with the input of a variety of interested parties including government agencies, non-governmental organizations (NGOs), private landowners, foresters, developers, and the agricultural community to determine the best strategies for recovering and managing DFS in Delaware (Figure 1), specifically in Sussex County, the only county where the species is known to occur in Delaware. This Plan is not a regulatory document; instead it makes recommendations to help secure the status of DFS in Delaware through state-lead projects, voluntary efforts and contributions of stakeholders and willing landowners.



Figure 1. Delmarva Fox Squirrel in the Winter. © Greg Pels

Goal and Objectives

The goal of the Plan is to increase and sustain DFS populations in Delaware with the ultimate goal of recovering the species so that it can be removed from both the state endangered species list (Title 7 Section 16 § 601) and the Species of Greatest Conservation Need (SGCN) list (Appendix A) of the Delaware Wildlife Action Plan. To accomplish this goal, specific tasks have been identified that focus on monitoring existing squirrel populations, identifying and maintaining suitable habitat and translocating squirrels to new areas.

Translocation is likely the only way to increase DFS populations within a reasonable time frame and that is why translocations are the cornerstone of this Plan. Delmarva fox squirrels have small home ranges (approximately 40 acres), low reproductive rates and tend not to travel far (dispersal, when it occurs, is typically three miles or less) (U.S. Fish and Wildlife Service [USFWS] 2008, 2012). Since the availability of suitable, unoccupied habitat is disjunct, it is unlikely that DFS populations can expand quickly without translocations.

At the time this Plan was written, DFS were listed as *Endangered* under the federal Endangered Species Act (7 U.S.C. § 136, 16 U.S.C. § 1531 et seq.) (ESA). However, the most recent USFWS status review considers the species to be recovered and recommends delisting (USFWS 2012). A proposal to delist the species is being drafted, and depending on public comments, delisting is likely by 2016. Thus, many of the actions in this Plan are contingent upon the removal of species from the federal ESA list.

- **Population Objective:** Double the number of locations where DFS occur and increase occupied habitat by a minimum of 900 acres (450 acres/site or more). Over the next five years (post delisting), establish and maintain two translocation populations/sites in addition to assessing and supplementing (if necessary) the existing DFS populations at Prime Hook National Wildlife Refuge (NWR) and Nanticoke Wildlife Area (WA). The USFWS population viability analysis (PVA) determined a need for 435 acres of suitable habitat supporting populations of 130 squirrels (0.3 DFS per acre) or more to ensure long term population persistence (USFWS 2012). Habitat will be evaluated for suitability for translocation using the Dueser Habitat Suitability Index Model (HSI) (Dueser 2000), through site visits and, if possible, the use of LIDAR. Occupied habitat will be defined as any forest where squirrels are detected and verified by trapping or photography in forest determined to be suitable DFS habitat.
- **Habitat Management Objective:** Promote forests that are at least 40 years old and riparian buffers along streams and wetlands (C. Keller, USFWS, pers. comm. 2013). Actively manage lands in and adjacent to occupied habitat that could be improved and used by DFS in the future. Monitor and adaptively manage the forest understory and invasive species as deemed appropriate. Explore the feasibility of collecting LIDAR data to determine mature forest/suitable habitat for DFS.

- **Habitat Connectivity Objective:** Over the next 15 years, promote habitat connectivity for DFS and other SGCN by encouraging and providing guidance for voluntary restoration, protection or management of connecting lands. Encourage maintenance of connectivity within and between DFS occupied sites for genetic interchange among populations. Explore the feasibility of future land acquisition of suitable habitat to provide connectivity for DFS.
- **Monitoring Objective:** Determine population estimates and occupied acres for existing populations and set up long-term population monitoring for existing and translocated populations. New populations will be monitored as outlined in the *Draft Translocation Plan* (Appendix B) and existing populations will be monitored using the guidelines in the USFWS' *Post-Delisting Monitoring Plan*, which will likely include trapping every two to three years to determine survival and recruitment. Other monitoring methods such as cameras, hair catchers, telemetry, etc. will also be employed to supplement trapping as deemed appropriate. The *Post-Delisting Monitoring Plan* is currently being drafted by the USFWS and will be posted on their website when it is completed.
- **Outreach Objective:** Engage, involve and inform key partners, stakeholders, and citizens to gain support for the management and recovery of the DFS in Delaware.

Expected Benefits to Species and Citizens

This Plan is expected to benefit DFS and the citizens of Delaware in several ways. Once DFS have been federally delisted, they will still be rare and listed as state endangered in Delaware. Increasing the species' distribution will help safeguard DFS locally and thereby reduce potential conflicts between protected species and activities that could impact the stability of the few populations that occur in Delaware. The forest habitat that will be managed for DFS in Delaware will still provide traditional recreational opportunities, such as hunting, hiking, horseback riding, and other activities (Urban Research & Development Corporation 2008). Another benefit will be that the plan will help promote compatible forestry that will also maintain green space and healthy landscapes for Sussex County residents and visitors. The value of open space and healthy forest ecosystems for water quality, esthetics, and quality of life have been well described (U.S. Environmental Protection Agency 2012, U.S. Department of Agriculture [USDA] Forest Service 2009). Forests help to mitigate air pollution and greenhouse gases, converting carbon dioxide into nutrients. Nationally, estimates of carbon storage by trees in forestlands are approximately 22.7 billion tons (USDA 2013). One acre of forest can absorb six tons of carbon dioxide and puts out four tons of oxygen, enough to meet the annual needs of 18 people (NJDEP 2013). Forests also help protect streams, rivers, and other water sources from increased sedimentation and nutrient runoff (McAvoy et al. 2006) and shade from trees lowers water temperatures in the summer and increases amounts of oxygen dissolved in the water (Maryland Department of Natural Resources Forest Service 2013).

GUIDING PRINCIPLES OF THE DELAWARE DIVISION OF FISH AND WILDLIFE

The Plan follows the Guiding Principles as developed by the Delaware Division of Fish and Wildlife (DFW).

Guiding Principles/Ideas:

1. We will manage populations of flora and fauna at socially acceptable levels.
2. We will maximize biodiversity
3. We will protect, improve, and restore native habitat.
4. We will provide and promote safe and enjoyable hunting and other wildlife related activities.
5. We will provide guidance to resolve human-wildlife conflicts.
6. We will educate all users about the value of wildlife and their benefits.
7. Decisions will be based upon science.
8. We will develop partnerships to develop and implement programs.
9. We will perform all activities in a professional manner in accordance with the Code of Ethics established by the Wildlife Society.
10. We will incorporate public opinion into our decision making process.
11. Will manage wildlife as a Public Trust Resource.

Guiding Principles/Philosophical Tenets – Defined:

Conserve Native Wildlife

1. Science must serve as the foundation for all our decisions.
2. We are committed to conserving biodiversity and the integrity of biological functions. We will manage native wildlife species as viable free ranging populations.
3. We will protect, improve and restore habitats and natural communities to preserve biodiversity.
4. We will restore native extirpated species.

Responsible Management/Recreation

1. We recognize that wildlife is a Public Trust Resource and fulfilling our mission requires public support and partnerships.
2. We will manage wildlife areas with a priority for wildlife and wildlife related activities.
3. We will provide assistance to resolve human-wildlife conflicts related to health, safety and economic impacts.
4. We recognize hunting and trapping as safe and legitimate management tools and outdoor pursuits.
5. We recognize that some land uses are inevitable and have negative impacts on wildlife populations. We will promote mitigation activities to offset these impacts and educate the public regarding trade-offs.

6. We will educate people about the benefits of wildlife benefits and instill a sense of responsibility and stewardship towards wildlife.

DELAWARE DIVISION OF FISH AND WILDLIFE AGENCY MISSION STATEMENT

Mission

Since 1911, the Delaware DFW has worked to conserve and manage Delaware's fish and wildlife resources, provide safe and enjoyable fishing, hunting, and boating opportunities to citizens and visitors, and improve the public's understanding and interest in the state's fish and wildlife resources through information and outreach programs. The DFW's goal is to manage and provide access to the lands with which DFW is entrusted for public use and enjoyment.

Statement of Values

The DFW's programs are developed and administered to serve the interests of all of the people of Delaware. We work with all segments of our constituencies to identify their needs and interests in fish and wildlife resources. Effective communication with the public is essential for the DFW to manage the state's fish and wildlife resources responsibly and with accountability. We advocate the humane use of fish and wildlife through observation and study, and promote humane hunting, fishing and trapping practices to ensure the continued existence of all species.

Strategic Priorities

Administration

The DFW works to administer its programs and activities effectively and efficiently. Our funding is used to promote the highest return on the investment of state, federal and constituent based fees and funds. Our administrative and management framework is specifically designed to facilitate DFW's complex and interrelated programs, projects and activities, while ensuring compliance with state and federal programmatic, financial and accounting practices and procedures. The development of policy and the documentation of program accomplishments provide the basis for evaluating the success of Division programs.

Applied Habitat Research, Management and Restoration

The DFW is committed to promoting and practicing the conservation of biological diversity by protecting against the unnecessary threat to or extinction of living species. DFW conducts research, and develops and implements policies that contribute to the maintenance, enhancement, restoration and management of natural habitats. Our habitat management practices benefit many fish and wildlife species and control undesirable species like mosquitoes or invasive vegetation that degrades wildlife and fisheries habitats.

Species Research, Monitoring and Management

The DFW promotes the understanding of fish and wildlife stocks and populations through species-specific research and monitoring programs. We recognize the diversity of our fisheries and wildlife constituencies and strive to actively involve these groups in policy development and public decision-making processes. The DFW works to balance human concerns with the need to prevent over- harvesting and exploitation of species to maintain and, if necessary, rebuild species stocks and populations to sustainable levels for both commercial and recreational users. The DFW also works to provide Delaware's citizens and visitors with an environment that minimizes nuisance or health impacts from pest species, as well as undesirable or invasive vegetation, in an environmentally-sensitive manner.

Enforcement

The DFW provides public safety services in the areas of boating, hunting, fishing, shell fishing and disaster response. The intent of these programs is to protect the public's safety, as well as that of the states' wildlife, finfish, shellfish, non-game and endangered species, including marine mammals, within the state's lands and waters.

Education and Training

The DFW administers education and training programs to improve awareness, appreciation and conservation of Delaware's natural resources. Through coordinated programs like hunter education, aquatic resource education and boating safety, our objective is to encourage sportsmanship, instill an environmental ethic and promote public safety among Delaware's citizens.

Acquisition, Facilities Development and Construction

The DFW develops and maintains public areas and facilities to ensure access to Delaware's natural resources. Our intent is to provide public hunting, fishing and wildlife viewing areas and boating access sites that are environmentally sensitive, modern, safe, clean and convenient so that Delaware's natural resources are available to all.

INTRODUCTION AND HISTORY OF DFS IN DELAWARE

Delmarva fox squirrels once ranged throughout the Delmarva Peninsula and into southeastern Pennsylvania and possibly New Jersey. As a subspecies endemic to the area, they are a special and valued part of Delaware's natural history. Restoring them to suitable, undeveloped habitats in their previous range in Delaware is both achievable and important. The overall conservation strategy of this Plan focuses on increasing the number of squirrels in the state. Although protection of habitat can help further the goal of the Plan, particularly if corridors and buffered waterways can be conserved, the majority of recovery actions revolve around translocations. Simply stated, the goal of the Plan is to increase the species distribution and ensure population stability through translocations and non-regulatory management of occupied habitats, connecting forests and supporting landscapes. The Plan includes actions such as population monitoring, forestry and development *DFS-Friendly Practices*, education and outreach and research. This Plan would also apply to any new DFS populations discovered in the state outside of Sussex County. Success will be measured in acres of occupied forest land, both currently occupied by DFS as well as where populations are established through translocation or natural dispersal.

In order to guide this Plan, it will be necessary to continually evaluate the status of the populations and the effectiveness of conservation actions by the DFW and its partners. This will be accomplished through surveys and monitoring as discussed in the *Draft Translocation Plan* and the USFWS' *Post-Delisting Monitoring Plan* assuming the species is delisted by the USFWS.

History of DFS in Delaware

The first DFS specimen recorded in Delaware was found near Wilmington around 1865. Gray collected a *Macroxus neglectus*, specimen (a synonymous designation for DFS) (Poole 1944) and it was noted as occurring in both northern and southern portions of the state (Poole 1944 and Barkalow 1956). However, by the early 1900's, DFS was extirpated from Delaware (Taylor 1976).

Since the time of its listing under the federal ESA in 1967, significant conservation efforts have occurred in the state. This included a translocation of squirrels from Maryland to Assawoman WA and Prime Hook NWR with subsequent management and monitoring efforts on these public lands. In 2001, a naturally occurring population was documented at the Nanticoke WA by trapping a single male on the west side of the Nanticoke River in the Pete Gum Tract. In subsequent years, DFS have also been documented at the nearby Dorman Tract and on the east side of the Nanticoke River on the Red House Tract. There have also been unconfirmed reports of sightings in other places in Sussex County. All likely reports were checked with photomonitoring but no other DFS populations have been documented.

In 2006, a Habitat Conservation Plan (HCP) was drafted to present conservation options to protect the squirrel and increase its range under the existing regulation of the ESA while attempting to minimize the regulatory burden that their presence may have caused for landowners and other entities. The initial draft of the HCP was completed, but was not revised or implemented due to legal issues regarding land use permitting authority. In 2012, the species

5-year review was completed by the USFWS. The thorough review of the status of the species and potential threats concluded that the species was recovered and recommended delisting. This recent history now creates an opportunity and need to develop this Plan as a means of continuing to protect and expand the range of the squirrels in Delaware.

NATURAL HISTORY

Taxonomy

The DFS is a large tree squirrel, in the order Rodentia, named by Linnaeus in 1758; synonyms include *S. n. neglectus* Gray and *S. niger bryanti* Bailey (Hall 1981). Other common names for the subspecies include Delmarva peninsula, Bryant, and peninsula fox squirrel, as well as gray, big-gray, stump-eared (Handley and Gordon 1979) and cat squirrel (Olstein and Koziol 1989). Recent genetic work by Moncrief et al. (2010) on *S. niger* found that genetic variation within populations and the species as a whole suggests that habitat loss and habitat fragmentation have not caused a complete loss of genetic variation in *S. n. cinereus*.

Species Description

The DFS (Figure 2), a heavy bodied squirrel, is silvery to grayish white with a full, fluffy tail, a white belly (USFWS 2008) and shorter ears than the common gray squirrel (USFWS 2012). The DFS is twice the size of the common gray squirrel, may grow to 25 - 30 inches (in.) (half of that as the tail), and weigh up to two to three pounds (Dozier and Hall 1944 and USFWS 2008). Generally, breeding occurs November through February with a peak in December and then April through July with a peak in June (Brown and Yeager 1945 and Moore 1957), with nesting occurring in tree cavities or leaf nests (USFWS 2008). Individuals reproduce at around 1.25 years of age (Harnishfeger et al. 1978), produce two to four young (Harnishfeger et al. 1978; McCloskey and Vohs 1971; Dozier and Hall 1944) and can have up to two litters per year (USFWS 2008). The DFS may live for seven years (Dueser 1999), but average three to four years (USFWS 2012).



Figure 2. Delmarva Fox Squirrel Feeding. © Greg Pels

Squirrels feed mainly on nuts and seeds from species found in mixed loblolly pine and hardwood forests such as green pine cones, and mast from oak, maple, hickory, walnut, and beech trees, food from farm fields (corn and soy beans), and tree buds/flowers, fungi, insects, and fruit (Weigl et al. 1989, Larson 1990 as cited in USFWS 1993) (USFWS 2008).

Preferred Habitats

Preferred habitats for DFS are mature stands of mixed pine/hardwood forest (Dueser et al. 1988, Dueser 2000, Morris 2006). These types of trees can be a plentiful food source of acorns, pine cones, and provide cavities for nests (USFWS 2012). Forest maturity, greater or equal to 40 years of age, is more likely to be habitat for DFS (C. Keller pers. comm. 2013) and squirrels have a home range of about 40 acres (USFWS 2008). Squirrel occurrences are generally defined as the area within three miles (mi.) of a confirmed DFS sighting, although squirrels have been documented traveling greater distances (USFWS 2012).

The Dueser HIS Model for DFS described suitable habitat as forest that has a high proportion of trees over 12 in. diameter at breast height (dbh), high canopy cover, low cover in the understory and plenty of pine (Dueser et al. 1988, Dueser 2000). These variables reflect forest maturity and canopy cover and diameter of trees were also important variables in a study of within stand patches where DFS occurred (Morris 2006). In addition, Morris (2006) found forest height has also been shown to be a significant indicator of where squirrels occur. As described in the USFWS 2012 5-year review (USFWS 2012 Appendix E) a LIDAR data model was developed in an effort to map tree height and subsequent DFS habitat across a large area. This model predicts suitable DFS habitat is within the tallest forest stands that averaged 66 years old (USFWS 2012) and had high canopy closure. Fieldwork confirmed this model. Squirrels may also prefer an open understory (Dueser et al. 1988, Dueser 2000) or areas where the vegetative understory is clumped with partial openings (Morris 2006 as cited in USFWS 2012) and with an understory closure that is less than or equal to 30 percent (Allen 1982). Although this open understory may be preferred, it may not be an absolute determinant for DFS occupancy (C. Keller pers. comm. 2013). Although DFS are likely to be found in older, mature forest, squirrels may also use younger woodlands at times to obtain specific resources, to move to more suitable mature habitat, or due to competition with other squirrels.

Population Estimate and Trend

Historically, DFS occurred in Delaware, Maryland, Virginia, and into southeastern Pennsylvania and possibly southern New Jersey (Rhoads 1903; Poole 1932, 1944; Allen 1942; Handley and Patton 1947; Mansueti 1952; Taylor 1973 as cited in USFWS 1993) (Figure 3); however, this species experienced a significant decline from historical levels by the mid 1950's (Dozier and Hall 1944, Taylor 1973). Clearing of land for agriculture and short-rotation timber harvest, were likely contributing factors. Over-hunting may also have affected insular populations and contributed to this decline (USFWS 2007). The DFS was federally listed due primarily to its disappearance from 90 percent of its former range (Taylor 1976).

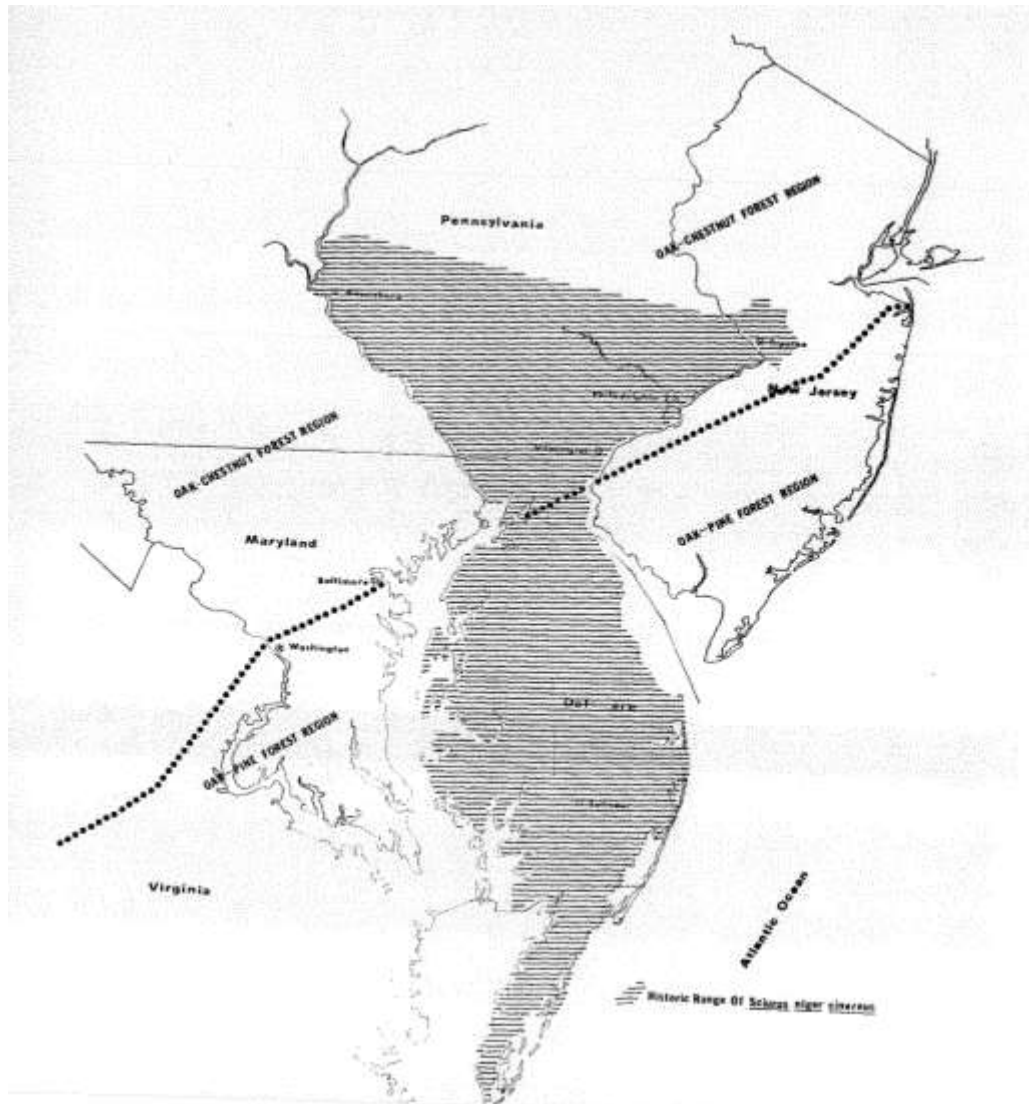


Figure 3. Historic Distribution of Delmarva Fox Squirrel and Forest Regions.
(According to Braun 1950 as cited in Taylor 1976)

Since the time of federal listing (1967), the DFS distribution on Delmarva Peninsula has expanded from four to ten counties and its range now extends over 28 percent of the Peninsula (Figure 4 and 5). In Delaware, DFS only occurs in two locations in Sussex County. The population is estimated at 182 squirrels (based on a density of 0.15 squirrels/acre and patch site of occupied sites at Prime Hook NWR and Nanticoke WA). In Virginia, DFS only occur in Accomack County. In Maryland, which supports most of the DFS population; the DFS occurred on 103,027 acres of forest in 1990 and now occurs on nearly 135,000 acres. This range expansion is a result of both the establishment of 11 populations through translocations (Figure 5) and the discovery of new or previously unknown populations. Eight new populations were described in the 2007 USFWS 5-year status review (and described in the *Distribution and Abundance* section), and new sightings between these populations further connect DFS into larger, more secure populations. The USFWS estimates that there are approximately 17,000 to 20,000 DFS distributed across the species' current range (USFWS 2012).

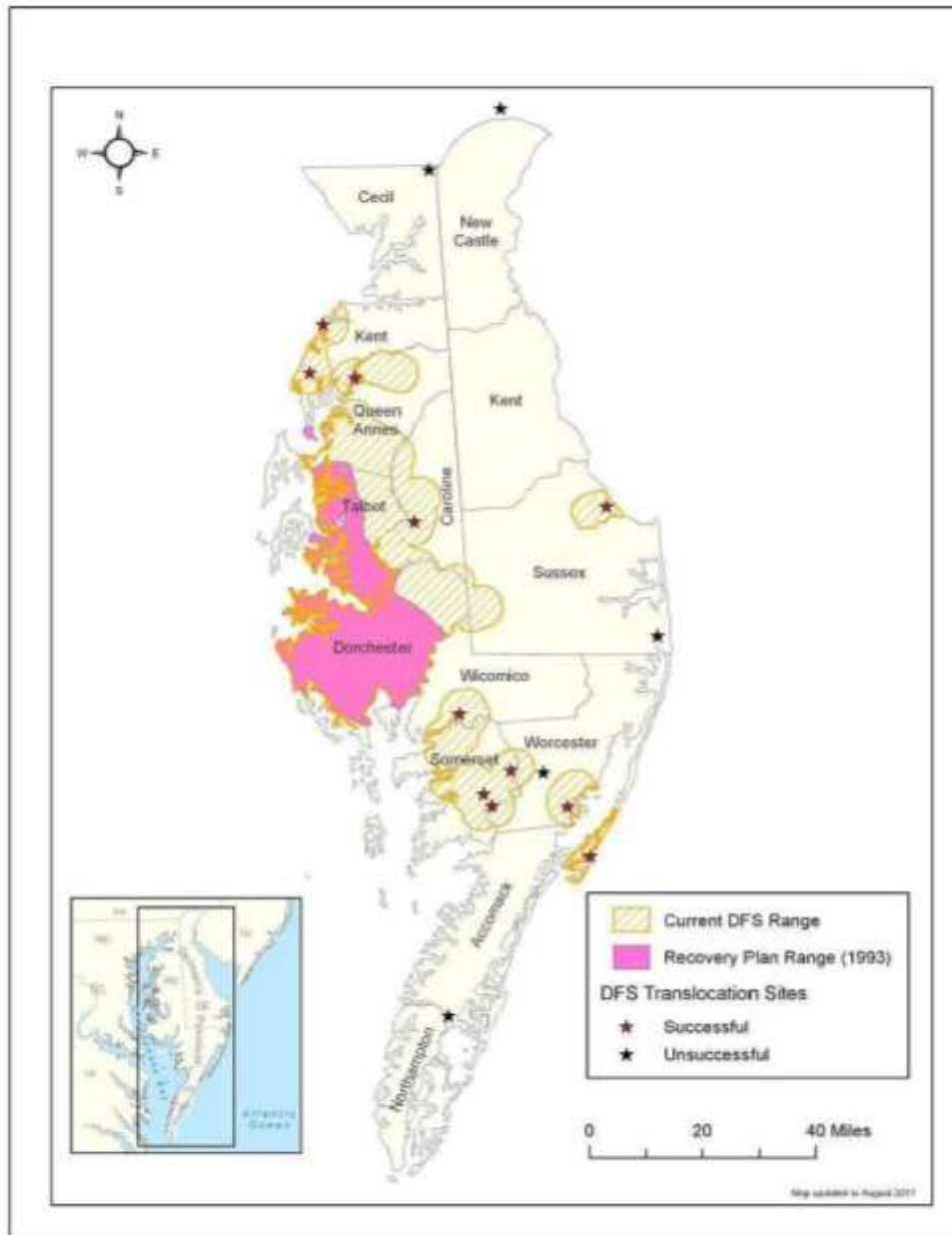


Figure 4. Range of the Delmarva Fox Squirrel During the Time the 1993 USFWS Recovery Plan was Developed Compared to the Range in 2011 in Maryland, Delaware, and Virginia.
(Source: USFWS 2012)

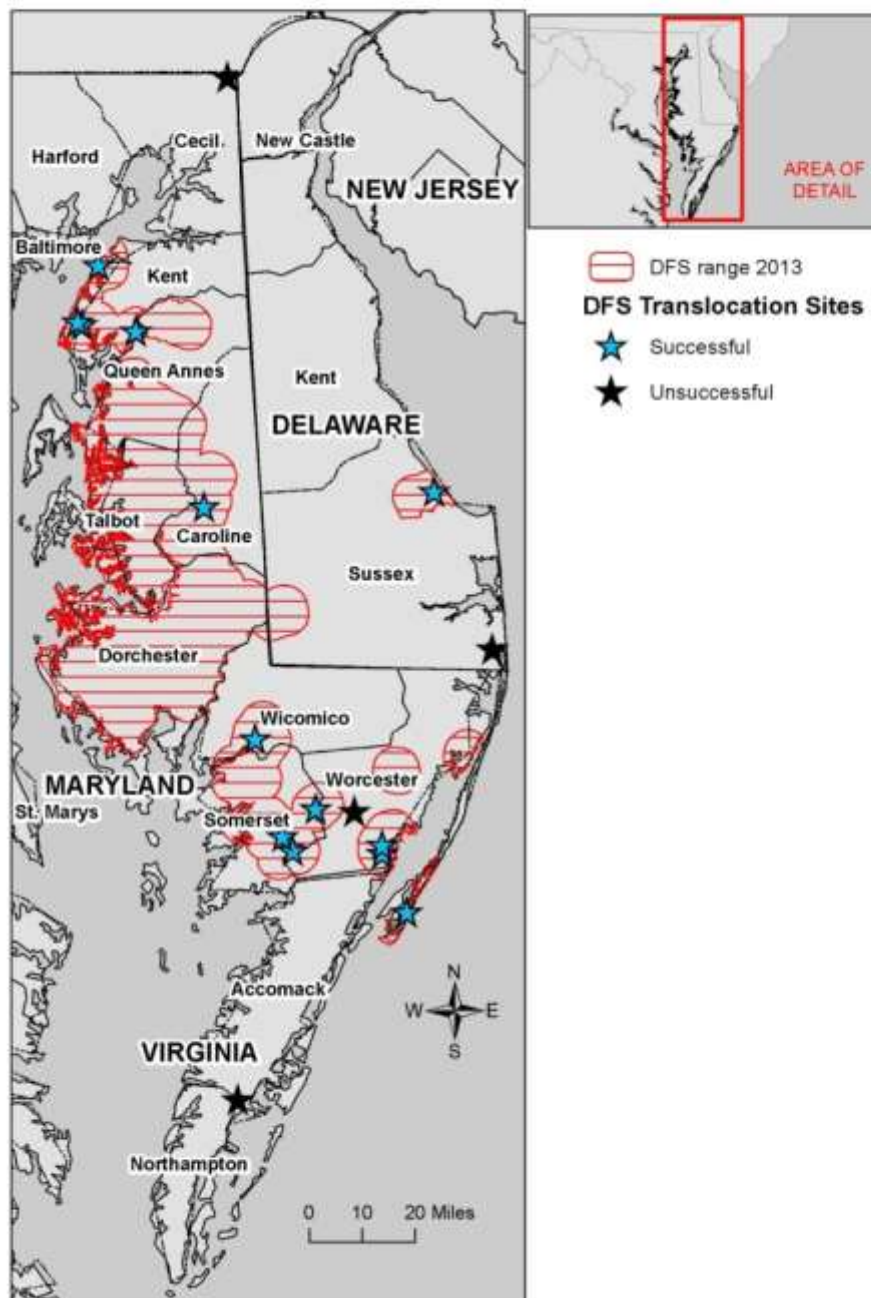


Figure 5. Current Range of the Delmarva Fox Squirrel Including Maryland, Delaware, and Virginia.

Distribution and Abundance

Although DFS were once widespread on the Delmarva Peninsula, most of the current population occurs in Maryland. By the time of federal listing in 1967, the remnant population of DFS occurred in only four Maryland Eastern Shore counties (USFWS 1993): Dorchester, Talbot, Queen Anne, and Kent Counties and was extirpated in Delaware and assumed to occur in Accomack County, Assateague Island, Virginia (introduced) (Taylor 1976).

Since 1998, eight new populations have been documented in addition to the 11 translocated populations (Figure 5) (USFWS 2007, 2012). The USFWS believes the eight locations are a result of new populations being discovered or dispersals from existing squirrel populations (USFWS 2012). The populations described in the USFWS 5-year review (USFWS 2007, 2012) are:

- Northeastern Dorchester County (Maryland)
- Southeastern Caroline County (Maryland)
- Tuckahoe River corridor (Maryland)
- Northern Queen Anne's County (Chino Farms) (Maryland)
- Centreville area of Queen Anne's County (Maryland)
- Kings Creek area of Talbot County (Maryland)
- Northern Somerset County (Maryland)
- Nanticoke WA in Sussex County (Delaware)

In its 2012 status review for DFS, the USFWS identified 22 subpopulations or areas of DFS occupied forest. Subpopulations were considered unique if separated from the nearest one by at least 2.25 mi. or had physical barriers such as large rivers (USFWS 2012). In Delaware, DFS are only confirmed to occur at Prime Hook NWR and Nanticoke WA in Sussex County (Figure 6). Estimated area of occupied habitat is between 800 and 1400 acres depending on how occupied habitat is defined.

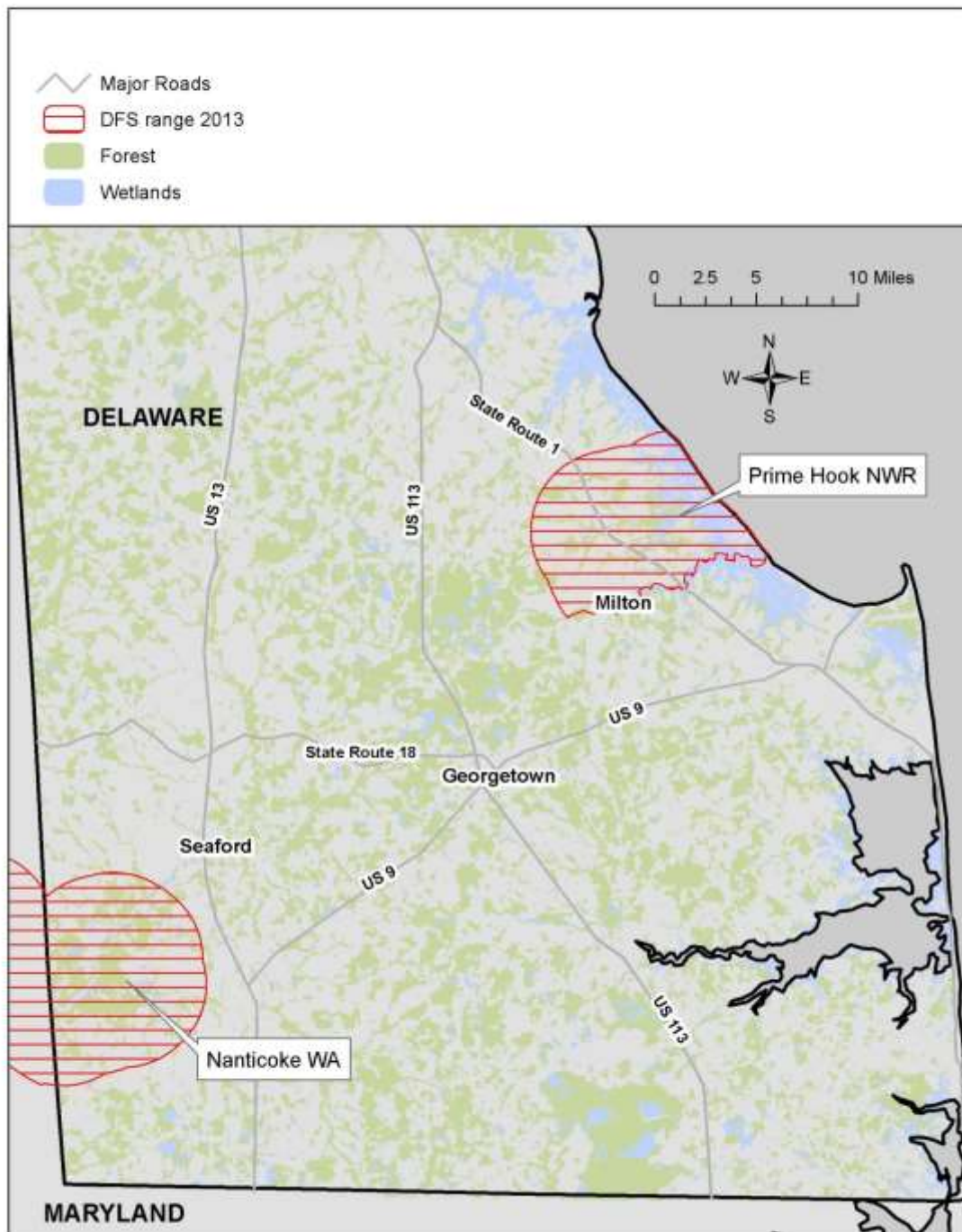


Figure 6. Current Delmarva Fox Squirrel Distribution in Sussex County, Delaware.

REGULATORY STATUS

Federal Status

Three federal recovery plans have been written for DFS, with the most recent one completed in 1993 (USFWS 1993). In 1984, the introduced population at Assawoman WA in Sussex County was determined as an *Experimental Population* in accordance with Section 10 (j) of the ESA (Federal Register Vol. 49, No. 67 Thursday, April 5, 1984) and therefore is treated as *threatened* for purposes under Section 9 (which includes *take* of endangered species) of the ESA (F.R. 1984). This allowed the USFWS and DFW more discretion in developing a management strategy for DFS at Assawoman WA.

In 2012, the USFWS completed a 5-year status review with updated information gathered since the 2007 5-year status review (USFWS 2007, 2012). It evaluated the status of the species' populations, habitat and threats. This 5-year review examined the squirrel's distribution and stability based on the best available data and the status of delisting criteria specified in the USFWS' 1993 Recovery Plan and conducted an assessment of the five listing factors (habitat changes, overutilization, disease or predation, inadequacy of regulatory mechanisms and other factors) to determine the appropriate classification of this species under the ESA. It concluded for the entire population (Maryland, Virginia, and Delaware) that DFS is not in danger of extinction throughout all or a significant portion of its range and that it is not likely to become *endangered* within the foreseeable future. In addition it noted that the USFWS anticipates that state laws and programs in Maryland, Virginia, and Delaware will continue to conserve forest habitat and wildlife, including the DFS, and that the DFS should it be delisted (USFWS 2012).

State Status in Delaware

Currently the DFS is listed as *endangered* in the state of Delaware (Title 7 Section 16 § 601). Pursuant to §601 of Title 7, the DFW may designate species of fish and wildlife that are seriously threatened with extinction as *endangered* species. Endangered status in Delaware protects the animals from importation, transportation, possession or sale of the animal or its hide or other parts. It also prohibits the sale or possession [with the intent to sell] of any article made from the skin, hide or other parts of the animal, except under license or permit from the DFW. The federal ESA protects against *take* (which includes killing the animals or disturbing them in any way that could affect their survival). The state law has no prohibition on *take* so, if they are delisted federally, there would continue to be no consultation needed for development, forestry or any other indirect impacts. It will still be illegal to kill them as per Delaware's hunting regulations.

CONSERVATION THREATS

The following information, summarized from the Recovery Plan (USFWS 1993), the Status and Recovery Plan Update (USFWS 2003) and 5-year Reviews (USFWS 2007, 2012), outlines the issues and problems facing the DFS throughout its range. Loss and degradation of habitat through forest conversion to agriculture and development (housing, roads, and industry) have contributed to loss of the DFS and its habitat. Incompatible timber harvesting, including overharvesting and short-rotation pine silviculture have also resulted in the loss or degradation of DFS habitat. Direct mortality from overhunting likely contributed to the species' decline earlier in the 20th century. However, according to the latest USFWS 2012 5-year review examining the population as a whole, the USFWS does not believe that the individual or combined effects from habitat changes, overutilization, disease or predation, inadequacy of regulatory mechanisms and other factors pose either a current or foreseeable risk of DFS extinction (USFWS 2012).

Potential threats to squirrels in Delaware that will be addressed in this section include habitat alteration from development and associated road mortality, short-rotation pine silviculture, land-clearing for agriculture, increased predation due human subsidized predators (i.e. pet dogs and cats, fox, raccoon) and natural predators (e.g. fox, hawks, coyotes). It also includes accidental shooting by hunters mistaking DFS for gray squirrels (it has been illegal to hunt DFS since they were federally listed as *endangered* in 1967). In this section, each threat is briefly described and evaluated for potential impacts to DFS (Figure 7).



Figure 7. Reproductive Female Delmarva Fox Squirrel. © Wil Hershberger

Habitat Loss from Development

As for many species of wildlife across the country and in Delaware, development has resulted in the loss of forest and other habitat for DFS. Unlike gray squirrels, DFS do not inhabit residential developments and are not considered a “suburban” animal (USFWS 2012). Delmarva fox squirrels do use forests near homes in lower density housing areas, such as single homes interspersed among forests and agricultural lands. However, the density of housing tolerated by DFS is still unclear (USFWS 2012).

As described in the USFWS 5-year review for DFS, development is not presently considered a serious threat to DFS regionally (Maryland, Delaware, and Virginia), largely because the USFWS predicts future residential development will occur outside of DFS’ range around larger cities (USFWS 2012). However, the USFWS review focused primarily on Maryland populations and the development trends in Delaware are not always focused around metropolitan areas. In this Plan, we will specifically look at habitat loss and development projections in Delaware, and more importantly, Sussex County and consider the potential impact to DFS in Delaware.

The human population within DFS historical range has increased significantly in recent years, and this has resulted in corresponding increases in developed land and losses of agricultural and forest land. Sussex County has experienced the highest rate of growth in Delaware - 11.7 percent increase from 2000 to 2005 (Delaware Population Consortium 2005). Growth in Sussex County is projected to increase by approximately 10,000 to 20,000 people every five years from a population of approximately 198,000 in 2010 to 277,000 by 2040 (Delaware Population Consortium 2012).

Sussex County is the fastest growing area in Delaware because of its popularity for primary residences as well vacation homes (Urban Research & Development Corporation 2008). This popularity has impacted development and may influence future development and possibly the loss of remaining unprotected forested lands. According to the Delaware Forest Service (2010) six percent of Delaware's remaining unprotected forests (16,000 acres) were included in proposed housing developments from 2002 to 2009.

In Delaware, the Office of State Planning Coordination (OSPC) offers a process by which a developer can submit their proposed project before starting the permitting process to see what regulatory issues there may be; called the Preliminary Land Use Service (PLUS). The OSPC will coordinate meetings with state regulatory agencies so that agencies can pursue questions with the developers and then later submit comments and recommendations if warranted. Based on data from projects submitted to PLUS in 2004 and 2005 alone, over 4,862 acres of forest (16,852 acres of all land types) were proposed for development in Sussex County. The most recent data on development was provided by Sussex County government (2013) and PLUS (2004-2013). Together, they illustrate the amount of residential development completed, lands zoned for residential development and areas that have been proposed for development. Not all the PLUS projects have resulted in projects being built (Figure 8).

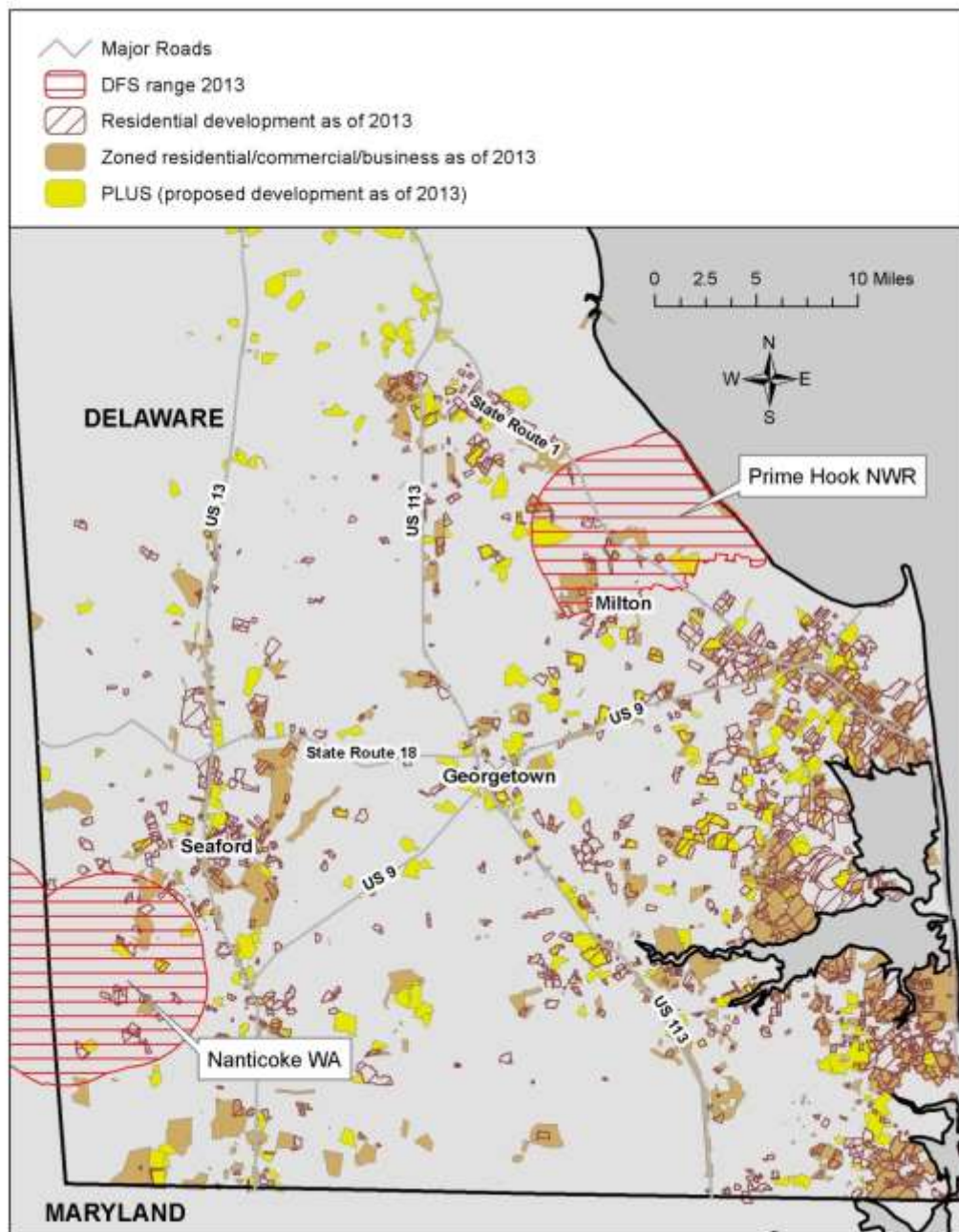


Figure 8. Residential Development, Zoned Development, and Proposed Future Development in Sussex County, Delaware.

Note: The Preliminary Land Use Service (PLUS) Layer Includes Proposed Projects From 2004 to 2013.

Information provided by the Delaware OSPC, Development Trends (2013), shows that residential units approved from **development applications** (approved but not necessarily built) have shown a general *decrease* from 2008-2011, yet residential units approved from **building permits** (actual building occurred or is occurring) from 2008 to 2011 have generally stayed the same state-wide and in Sussex County (See Tables 1 and 2). Because building permit information is actual, rather than speculative, it is a better indicator of actual market demand and development trends (Delaware OSPC, Development Trends 2013). State-wide, 80 percent of these residential building units approved by permit were in designated “growth areas;” however, in Sussex County, there was less development in “growth areas” with 28 percent of building permits approved in rural areas (Delaware OSPC 2012).

Table 1. Residential Units Approved by Development Application, by County, 2008 through 2011.

(Derived from The Delaware Office of State Planning, Development Trends, accessed September 2013)

	2008 Total	2009 Total	2010 Total	2011 Total
State-wide	10,324	4,350	6,087	4,529
New Castle County	3,070	357	3,989	2,433
Kent County	3,536	1,455	563	196
Sussex County	3,718	2,538	1,535	1,900

Table 2. Residential Units Approved by Building Permit, by County, 2008 through 2011.

(Derived from The Delaware Office of State Planning, Development Trends, accessed September 2013)

	2008 Total	2009 Total	2010 Total	2011 Total
State-wide	3,943	3,199	2,918	3,213
New Castle County	974	770	784	641
Kent County	1,246	729	579	863
Sussex County	1,723	1,700	1,555	1,709

There were more residential **development applications** from 2008 to 2011 in the northern part of the state outside of Newark and Middletown and some in Sussex County. There were also more **residential building permits** from 2008 to 2011 in the northern part of the state and around towns, like Smyrna, Dover, and along the Atlantic coast of Sussex County (The Delaware Office of State Planning, Development Trends, 2013).

Despite all the actual and projected growth in Sussex County, there is adequate forested habitat for DFS, much of which is on protected lands. The Delmarva Peninsula is primarily privately-owned land but there is extensive acreage in conservation easements that protects land from future development (USFWS 2012). Specifically, in Delaware, there are approximately 100,000 acres or over one-quarter of Delaware’s forest land protected from development (Figure 9). These lands include government-owned and non-government-owned tracts, as well as areas

protected by permanent conservation easements including over 22,000 acres of forestland protected through easements purchased by the Delaware's Agland Preservation Foundation (Delaware Forestry Service). Under the Agland Preservation Foundation, the forestlands included in a forestland preservation area are subject to restrictions including, but not limited to, no conversion of the forestland to cropland, pasture land, open space or other types of land uses. Upon acquisition of a forestland preservation easement the lands subject to such easement shall form a permanent forestland preservation area (permanently protecting the land) (Chapter 9. Delaware Agricultural Lands Preservation Act, Subchapter V. Forestland Preservation).

Taking all parts of the equation into consideration (past, current and projected development, current protected lands, continuing land protection efforts and the goals of this plan), potential impacts from development will be minimal or nonexistent. Even though development can stifle dispersal of DFS, there is enough habitat protected to sustain the species as long as there is also species management and translocations onto lands they could not otherwise disperse to because of roads and development. Without assisting the spread of the species in Delaware, however, their continued presence in Delaware is less certain.

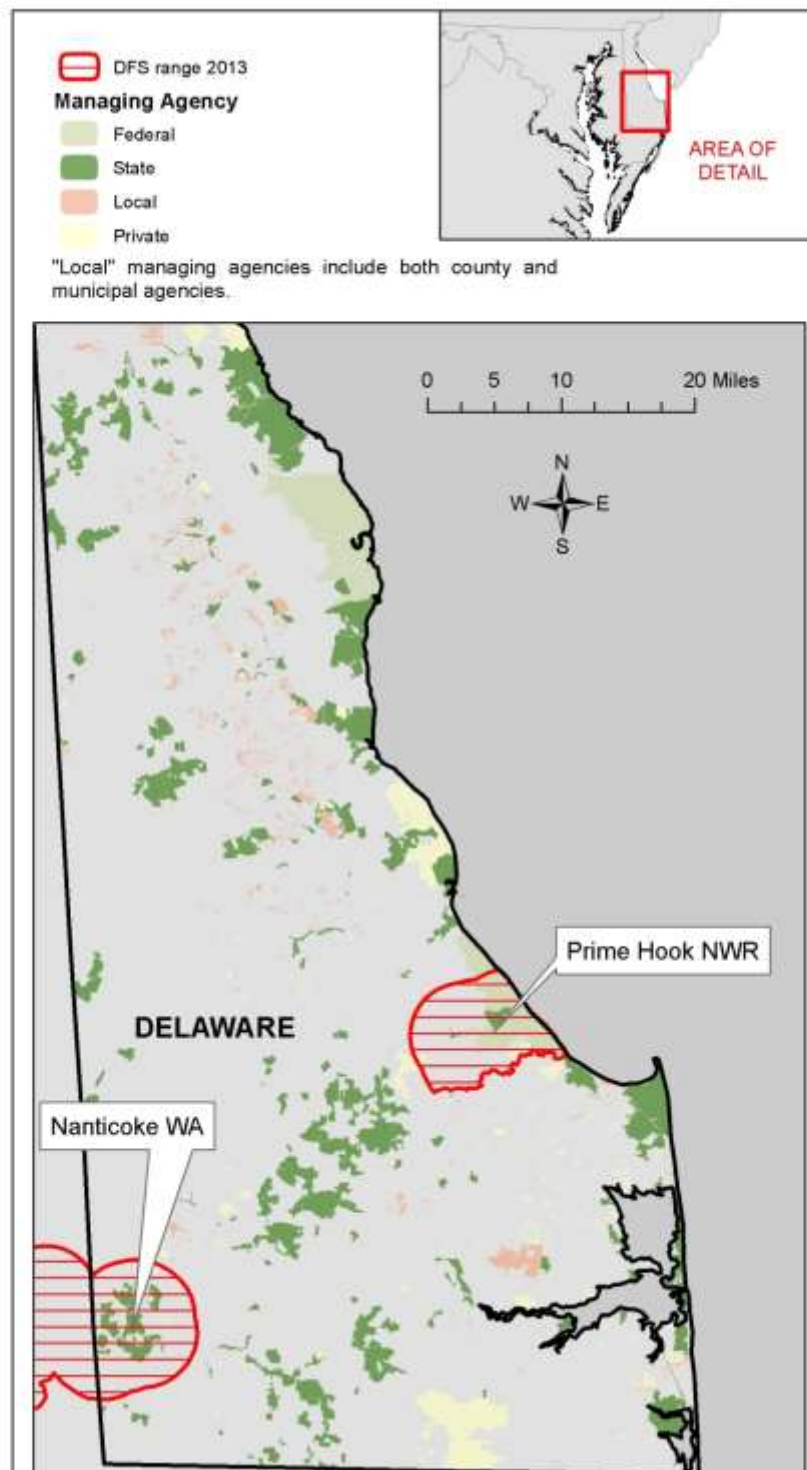


Figure 9. Federal, State, Local and Private Protected Lands in Delaware.
(Source: Outdoor Recreational Inventory 2011)

Habitat Changes Due to Agriculture and Forestry Management

Although early clearing of forests likely contributed to the original decline of DFS, modern harvest levels and practices in Delaware are not likely to limit DFS population growth. The 2012 USFWS Status Review indicates that the DFS can be sustained and recovered in working landscapes of agriculture and forestry.

Most of Delaware was forested at the time of European settlement. Much has regrown and much of the regrowth has been cut again. The amount of forest loss since regrowth is difficult to determine with accuracy, but it has been estimated at 50 to 75 percent. The loss of forest was probably greater than 75 percent at its 19th century peak since some existing forest represents regrowth that has occurred on abandoned farmland, especially in the northern part of the state. Calculations of Delaware forest loss over the past approximately 25 years have been estimated at 35,000 acres from 1984 to 1992 and 20,000 acres from 1986 to 1999. In 2005 alone, loss was estimated to be as high as 4,500 acres. Historically, this loss stemmed from conversion to agriculture, but more recently is the result of residential and commercial development and associated infrastructure (Delaware Department of Natural Resources and Environmental Control [DNREC] 2006).

As a result of property subdivision, development, roads and other agricultural land conversion activities, Delaware's remaining forests are in smaller blocks than they once were; the number of contiguous forested blocks over 250 acres is decreasing (Delaware Forest Service 2010). Mapping of Delaware's tree cover in 2004 delineated about 4,150 separate wooded patches larger than ten acres. The median size of those patches was just 34 acres, and only six percent were larger than 250 acres (DNREC 2006). Today's average forest ownership is less than ten acres, compared to over 30 acres just three decades ago (Delaware Forest Service 2010).

Tables 3 and 4 and Figure 10 illustrate clearcut and selection timber harvests throughout Delaware and specifically in Sussex County. Over the last 16 years, the average acres of timber harvest (clearcuts and selection) throughout Delaware has ranged from 43 acres to 25 acres per permit (Table 3). In Sussex County over the last 16 years, the average acres of timber harvest (clearcuts and selection) has remained similar to the statewide average, and ranged from an average at 52 acres to 22 acres per permit (Table 4). If the timber harvests continue to stay as small in acreage as demonstrated in the past few years impacts to DFS will be minimal (C. Keller pers. comm. 2013).

Table 3. Delaware (state-wide) Timber Harvest Summary Clearcuts and Selection (1997-2012).

(Compiled by the Delaware Forest Service 2013)

Sum and Averages of Clearcut and Selection Harvests									
	Total		Type				Averages		
Year	Total Clearcut And Selection Permits	Total Clearcut and Selection Acres	Clearcut Permits	Clearcut Acres	Selection Permits	Selection Acres	Avg. Size of Clearcut + Selection Harvests	Avg. Size of Clearcut Harvests	Avg. Size of Selection Harvests
1997	126	4,526	83	3,553	43	973	36	43	23
1998	110	4,434	56	2,870	54	1,564	40	51	29
1999	96	2,999	54	1,904	42	1,095	31	35	26
2000	132	5,418	81	3,888	51	1,530	41	48	30
2001	109	4,645	62	2,344	47	2,301	43	38	49
2002	133	4,097	74	2,609	59	1,488	31	35	25
2003	135	4,636	87	3,208	48	1,428	34	37	30
2004	108	3,634	59	2,181	49	1,453	34	37	30
2005	120	3,655	74	2,446	46	1,209	30	33	26
2006	120	3,352	73	1,979	47	1,373	28	27	29
2007	114	2,944	58	1,690	56	1,254	26	29	22
2008	99	2,689	41	1,232	58	1,457	27	30	25
2009	85	2,129	40	1,211	45	918	25	30	20
2010	83	3,295	47	2,323	36	972	40	49	27
2011	88	2,298	39	876	49	1,422	26	22	29
2012	84	2,815	43	1,259	41	1,556	34	29	38

Note:

Thinning not included as this practice is considered beneficial to DFS habitat

Every year, some permits had more than one box checked for Type.

All harvests with Clearcut box checked were considered clearcuts.

Any non-clearcuts with Thinning box checked were considered thinnings.

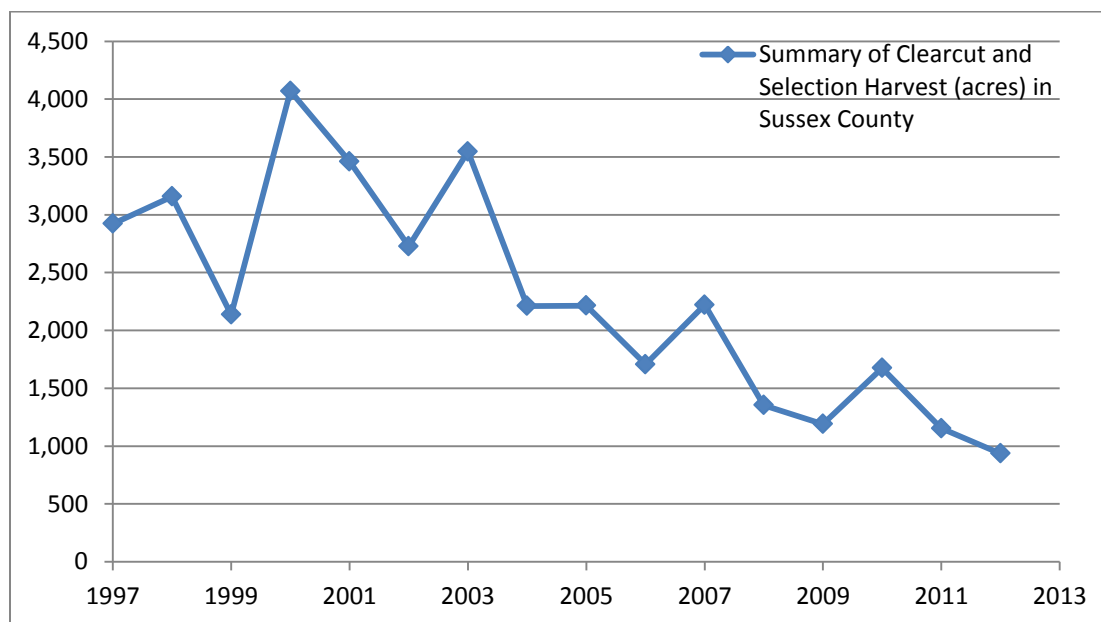
Selection harvest acreages were calculated by subtraction.

**Table 4. Sussex County, Delaware Timber Harvest Summary Clearcuts and Selection
1997-2012.**

(Compiled by the Delaware Forest Service 2013)

Summary of Clearcut and Selection Harvests			
Year	Permits	Acres	Avg. size of harvest
1997	83	2,922	35
1998	68	3,158	46
1999	62	2,137	34
2000	89	4,069	46
2001	67	3,461	52
2002	86	2,727	32
2003	98	3,547	36
2004	67	2,212	33
2005	82	2,214	27
2006	77	1,707	22
2007	83	2,221	27
2008	53	1,354	26
2009	47	1,191	25
2010	43	1,675	39
2011	45	1,154	26
2012	33	936	28

Note: Thinning not included as this practice is considered beneficial to DFS habitat



**Figure 10. Acres of Clearcut and Selection Harvests in
Sussex County, Delaware, 1997 to 2012.**

Note: Thinning not included as this practice is considered beneficial to DFS habitat

Recent research has been conducted to better understand the effects of timber harvest on DFS. Bocetti and Pattee (2003) conducted a long-term study on the effects of modified clearcuts on DFS density, survivorship, home-range size and home range location shifts. Preliminary results demonstrated that the catch-per-unit-effort (CPUE) did not change for DFS three years after clearcut harvests were conducted (as compared to three years before the harvests), but did decrease for gray squirrels. However, further years of data showed declines (~50% decrease in CPUE, but not extirpation) in areas where woodlands were clearcut (Loeser and Bocetti 2009). Telemetry indicated there were no direct mortality events and movement of radio-collared DFS was not predictable based on the harvest as squirrels moved toward and away from the harvest sites. However, it should be noted that clearcuts were only 40 to 50 acres in size and there was surrounding suitable habitat for DFS. This is similar to results found by Paglione (1996), who evaluated the movement of DFS from clearcuts on Blackwater NWR (Dorchester County, Maryland). Paglione (1996) found that DFS shifted into nearby suitable habitat following a harvest and no direct mortality events were observed. Timber harvest, when done on small scales and/or near uncut woodlands of suitable habitat are not likely to have an adverse impact on DFS.

Overutilization (Hunting)

Delmarva fox squirrel hunting was banned in 1972 throughout the species' range (USFWS 2012). In its recent 5-year review, the USFWS stated that hunting does not currently pose a risk to the extinction of the species, but may have been a factor in their decline, especially in the 1950's and 1960's (USFWS 2012). Similarly in Delaware, the potential for a hunter to harvest a DFS has declined due to a reduction in both the number of squirrel hunters and the squirrel harvest.

The DFW has seen a steady decline in small game hunting participation across the state which has translated into a similar decline in total harvest. The peak number of gray squirrel hunters and harvest occurred in the early 1970's when nearly 13,000 squirrel hunters harvested nearly 100,000 gray squirrels. The last few seasons, there have been around 2,000 hunters that have pursued squirrels with an estimated total take around 13,000 squirrels (Figure 11; J. Rogerson, Delaware DFW, pers. comm. 2013). Based on this 85% decline in hunters and the 87% percent decline in squirrel harvest, the DFW suspects that the potential to accidentally harvest a DFS has also decreased proportionally (J. Rogerson pers. comm. 2013).

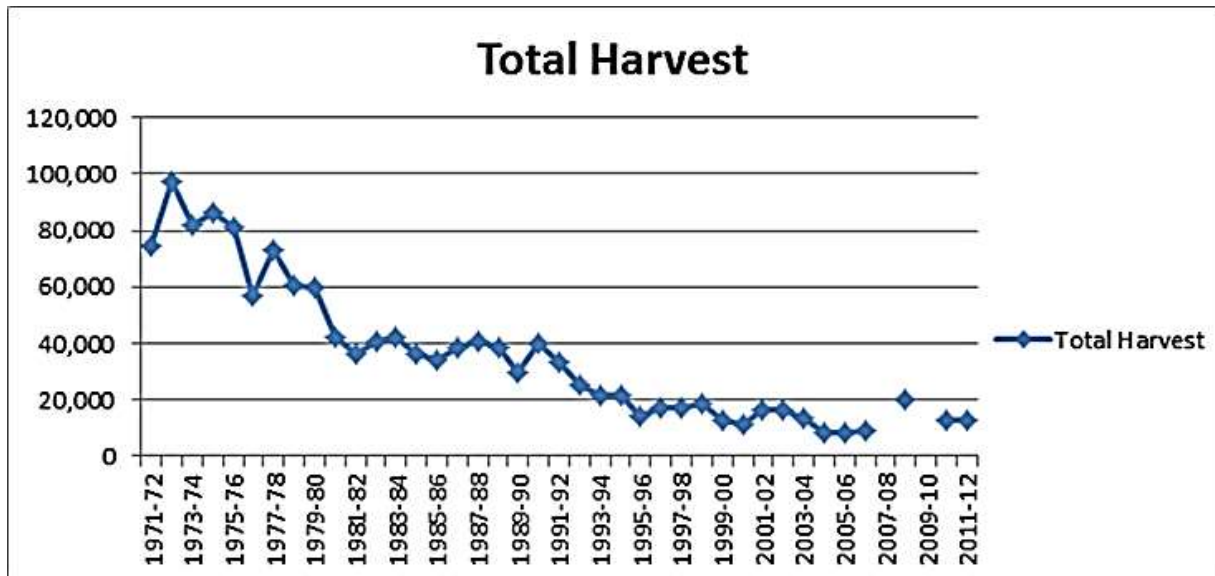


Figure 11. Gray Squirrel Harvests in Delaware Summarized from the Delaware Division of Fish and Wildlife Annual Hunting Surveys (1971–2012).
(Compiled by J. Rogerson, Delaware DFW 2013)

The DFW is aware of at least one DFS being taken, perhaps accidentally, at Nanticoke WA (T. Pritchett, Delaware DFW Enforcement, pers. comm. 2013), but does not have any historical records of DFS harvest (J. Rogerson pers. comm. 2013). In an effort to avoid cases of mistaken squirrel species identity, the Delaware DFW’s 2013-2014 hunting guide (Delaware DFW 2013) contains information highlighting the difference between the gray squirrel and DFS. If DFS are federally delisted and then removed from the state endangered species list, it is unlikely a hunting season would be opened in the near future. Hunting of DFS would not be permitted until studies show that populations could withstand the added pressure.

Global Climate Change and Sea Level Rise

The USFWS 2012 5-year status review analyzed the effects of climate change and sea level rise on the entire DFS range by using worst-case scenarios with a 24 in. sea level rise in 40 to 50 years. Habitat losses for DFS populations along the Atlantic side of the Delmarva Peninsula are anticipated. However, the USFWS anticipates some DFS will shift to more interior sites on the Delmarva Peninsula (USFWS 2012). Regarding the entire DFS population and the loss of its habitat, the USFWS does not believe this sea level rises poses an extinction risk (USFWS 2012).

However, looking at Delaware alone, this sea level rise would likely affect the DFS population at Prime Hook NWR. Locally in Delaware, the rate of existing sea level rise has been estimated to be 3.20 ± 0.28 mm/yr., (95 percent confidence interval), which calculates to 1.05 feet in 100 years (See Figure 12) (National Oceanic Atmospheric Administration [NOAA] Lewes, DE, Tide Gauge: http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8557380; accessed August 2013). This is almost double the average global rate of sea level rise at 1.7

mm/yr. (IPCC 2007). The DNREC Sea level Rise Technical Workgroup also proposed the use of three planning scenarios for accelerated local sea level rise at 0.5, 1.0, and 1.5 meters and focused its efforts on researching and developing recommendations that will build the state's capacity to adapt, rather than pinpointing adaptation measures that should be used in specific locations (S. Love, Delaware Coastal Programs, pers. comm. 2013).

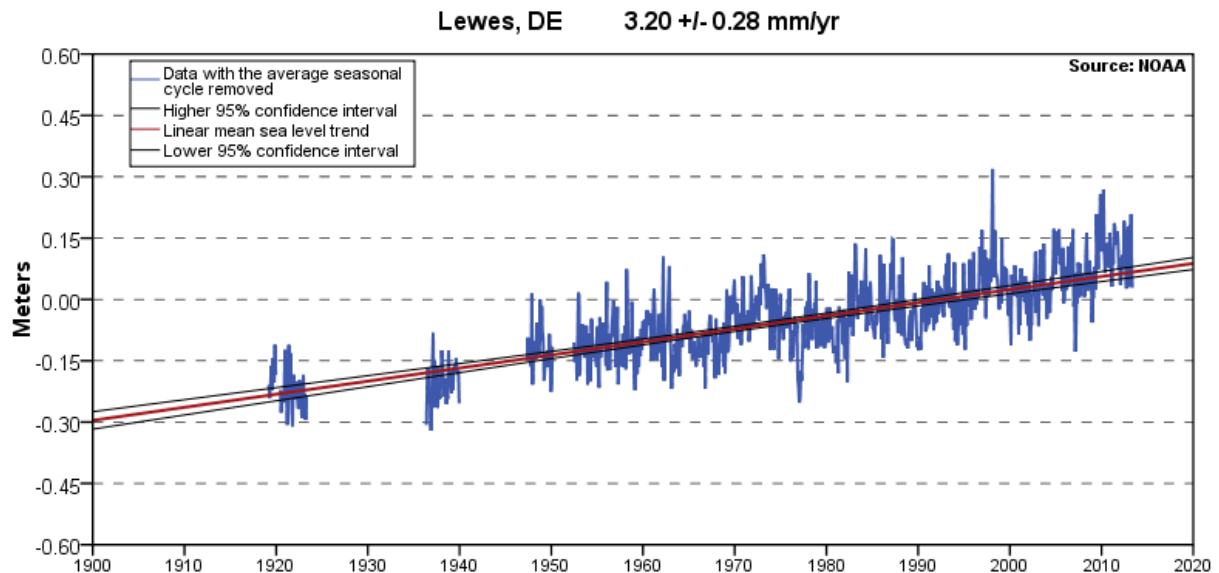


Figure 12. Mean Sea Level Trend Lewes, Delaware.
(Source NOAA: Accessed August 2013)

Under the Prime Hook NWR 2013 Comprehensive Conservation Plan (CCP) (USFWS 2013), the conversion of forested areas to emergent wetlands and a displacement of wildlife are predicted impacts due to climate change. As discussed in the 2013 CCP, the Delaware Coastal Program conducted a *Sea Level Rise Affecting Marsh Model* exercise and predicted by the year 2050, half of the current upland area of Prime Hook NWR will be lost (either converted to wetlands or open water), decreasing from 20 percent to, at most, 12 percent of the current land base. Under the worst case scenario, by the year 2100, up to 88 percent of Prime Hook NWR could be open water or tidal mud flats and only one percent of Prime Hook NWR would be uplands. Protecting adjacent and connective habitat to Prime Hook NWR for potential DFS movement will be essential as changes to the climate and sea level rise continues. Currently the Wildlife Management Plan for Nanticoke WA does not address climate change impacts to protected species. Nanticoke WA now uses an Annual Work Plan approach to operations and planning, but sea level rise is not currently addressed.

Depredation/Disease

Depredation and disease have not been significant threats to DFS in the past 40 years as populations have continued to increase range wide despite the presence of predators and minor diseases (USFWS 2012).

DFS numbers may increase or decrease due to changes in predators but these appear to be very specific local events (USFWS 2012). Natural predators of DFS include bald eagles (*Haliaeetus leucocephalus*) red-tailed hawks (*Buteo jamaicensis*) and other raptors, red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*) and possibly feral animals and domesticated pets (e.g. cats and dogs) (USFWS 2012).

However, unforeseen predation and disease (something analogous to white nose syndrome in bats) that could impact DFS (Figure 13) is possible and would be managed accordingly to ensure long-term survival of DFS in Delaware. However, communicable diseases are not likely to be a factor with this species since they are largely solitary; generally only coming in contact with other DFS during breeding, raising young and sometimes during cold weather.



Figure 13. Two Young Delmarva Fox Squirrel. © Wil Hershberger.

Vehicle Strikes

Road mortality of DFS does occur. However, they appear for be local events and related to the abundance of squirrels in a particular area or based on the proximity of DFS habitat to the roadway (USFWS 2012). Road mortality alone is not a pervasive threat or an extinction risk for this species at this time (USFWS 2012).

CONSERVATION STRATEGIES AND ACTIONS

This section describes both general and specific actions that will be used to increase DFS populations in Delaware. The DFW will implement and update this Plan as a landscape-level conservation plan for existing populations, new populations and future perpetuation of DFS in Delaware. The DFW will encourage land protection and management at a landscape level with willing landowners and partners. Land management efforts will focus on currently occupied and translocation sites, but management of connecting forests and stream corridors by public and private entities will be encouraged by providing information and advice to interested parties.

A GIS exercise was done for this plan to determine potential translocation sites and dispersal and connecting corridors to connect occupied DFS sites and translocation sites. The results align well with results of The Delaware Ecological Network (DEN), a statewide conservation modeling program developed by The Conservation Fund. The DEN produced landscape level GIS data including core forest areas (large intact forest ecosystems that provide high-quality habitat for native wildlife and flora) (Weber 2007) and connecting corridors. Areas that have been identified by DEN as core areas are also in-line with the sites being evaluated for DFS translocations.

Delaware DFW plans to coordinate with willing public and private landowners, foresters, governmental agencies, and other key stakeholders by providing information about *DFS-Friendly Practices* and gauging interest in assisting with the DFS recovery; specifically in priority areas (in and near occupied and potential translocation forests and connecting corridors). The Delaware Forest Service's Strategy (2010) also supports the protection of forests through a combination of public and private funding. They plan to continue to provide existing incentives, and will likely explore opportunities for new incentives for willing landowners to maintain their forestland. They also encourage state, county, and local governments to incorporate forests and forest benefits into their land-use planning processes. The Delaware Forest Service Resource Assessment recognizes the importance of DFS on the landscape. The DFW will also discuss options for coordination with the USDA's Natural Resources Conservation Service (NRCS) to determine which of their programs and habitat incentives are compatible with DFS conservation.

Through this Plan, DFW strives to increase DFS populations in Sussex County, Delaware (and any new locations should they be discovered) through the scientific basis that was initially developed in the HCP and is now being carried forward into this Plan. The primary emphasis will be on increasing the species' distribution through translocating squirrels, habitat management activities at new and existing sites and voluntary land protection and management activities on supporting landscapes (connecting and adjacent forests).

Management objectives and strategies will focus on:

- Translocation of squirrels into two new, carefully selected forest lands with participation of willing landowners and partners.

- Habitat connectivity that allows for natural dispersal and connectivity of DFS between core areas.
- Timber management that is compatible with DFS where they occur and are introduced.
- Conservation of DFS and their habitat through targeted research and management of the habitat/wildlife relationships.
- Outreach efforts regarding DFS conservation and protection efforts.

Delaware DFW will also take a landscape level approach by providing DFS friendly suggestions to interested parties via this plan and other outreach efforts. Background information and specific goals are detailed in this section.

Increase DFS Populations and Occupied Habitat in Delaware

Through this Plan DFW strives to increase DFS populations and occupied habitat in Delaware through long-term population surveying and monitoring, translocations, maintenance of habitat connectivity (or future land acquisition for connectivity) within and between squirrel-occupied sites.

Translocation

One of the most important aspects in planning a DFS translocation is the identification and assessment of suitable habitat (USFWS 2006 as cited in Terwilliger 2012). Any translocation of DFS into suitable habitat will be conducted in accordance with the *Draft Translocation Plan* for the Delmarva Fox Squirrel in Delaware. They will be conducted with the participation and consent of willing landowners and include the development of specific, mutually agreed upon Memorandum of Understandings (MOUs).

The DFW has developed a preliminary list of potential translocation sites based on habitat size, connectivity and level of current protection (Note: This list is the result of GIS exercises to determine biologically feasible options for translocation sites and, as such, no landowners or land managers have been approached [except Delaware Forest Service]). All the areas identified meet the following criteria:

- Release site should have sufficient acreage of appropriate habitat on-site or contiguous with the site to support a viable DFS population. Results of recent PVA model (Hilderbrand et al. 2004) suggest an area containing 435 acres of suitable habitat (the area does not have to be one piece, but has to be connected to other forest blocks).
- Release site should be located in an area that allows for dispersal beyond the original release site to accommodate an expanding population.

Inclusion in this list only indicates some level of potential for consideration for translocation of DFS, and each site will require evaluation both by the DFW and its partners for biological and

land use suitability. Evaluation of sites will involve examining recent aerial photos, obtaining historical land-use/silviculture information and on-site assessments (HIS surveys and evaluation of site characteristics). An additional evaluation tool would involve using the LIDAR data model as described in Appendix E of the DFS 5-yr review (USFWS 2012) and also described in the *Preferred Habitats* section of this Plan.

Suitable sites will also need to meet the following criteria:

- Release site should score above average on the DFS HSI model, which means it should have a large proportion of trees ≥ 12 inches in dbh, high and primarily closed canopy and relatively open understory, which can be interspersed with shrubs and forbs.
- Site should be protected from incompatible habitat alterations for a period of at least 20 years.
- Site should be in close proximity to other protected and/or private lands that will allow for safe dispersal.
- Access for release and monitoring purposes must be granted by the willing landowner and the MOU must be in place prior to translocation.
- It is important to release source animals in selected sites that have similar habitat as source habitat where animals were trapped (i.e. hardwoods to hardwoods, pine to pine).
- Each site would be guided by habitat and DFS conservation actions included in an approved plan, such as a Forest Stewardship Plan or an MOU.

Acreage of 5 potential translocation sites (Old Furnace WA, Midlands WA, Trap Pond State Park, Redden State Forest, and Great Cypress Swamp) are described in Table 5 and depicted in Figure 14. The percentage of forested acres on Redden State Forest that is greater than 40 years old and may be suitable for squirrel translocation was calculated at 46 percent (E. Burkentine, Delaware Forest Service, pers. comm. 2013).

Table 5. Potential Translocation Sites and the Forest Acres That May Support an Introduced Delmarva Fox Squirrel Population.

Note: Forests listed here may not necessarily be suitable habitat for DFS; further data is needed before determining suitability for translocations.

Owner	Site/Tract Name	Total Acres	Forest Acres	No. of Potential Translocation Sites (Forest Acres / 435 Acres)
State - DDA	Redden State Forest	14,164	12,840	30
State - DFW	Old Furnace Wildlife Area	1,991	1,742	4
	Midlands Wildlife Area	4,083	2,063	5
State - DPR	Trap Pond State Park	3,630	2,721	6
Private Conservation	Great Cypress Swamp	9,590	9,196	21
Total		31,833	28,562	66

DDA = Delaware Department of Agriculture

DFW = Delaware Division of Fish and Wildlife

DPR = Delaware Division of Parks and Recreation

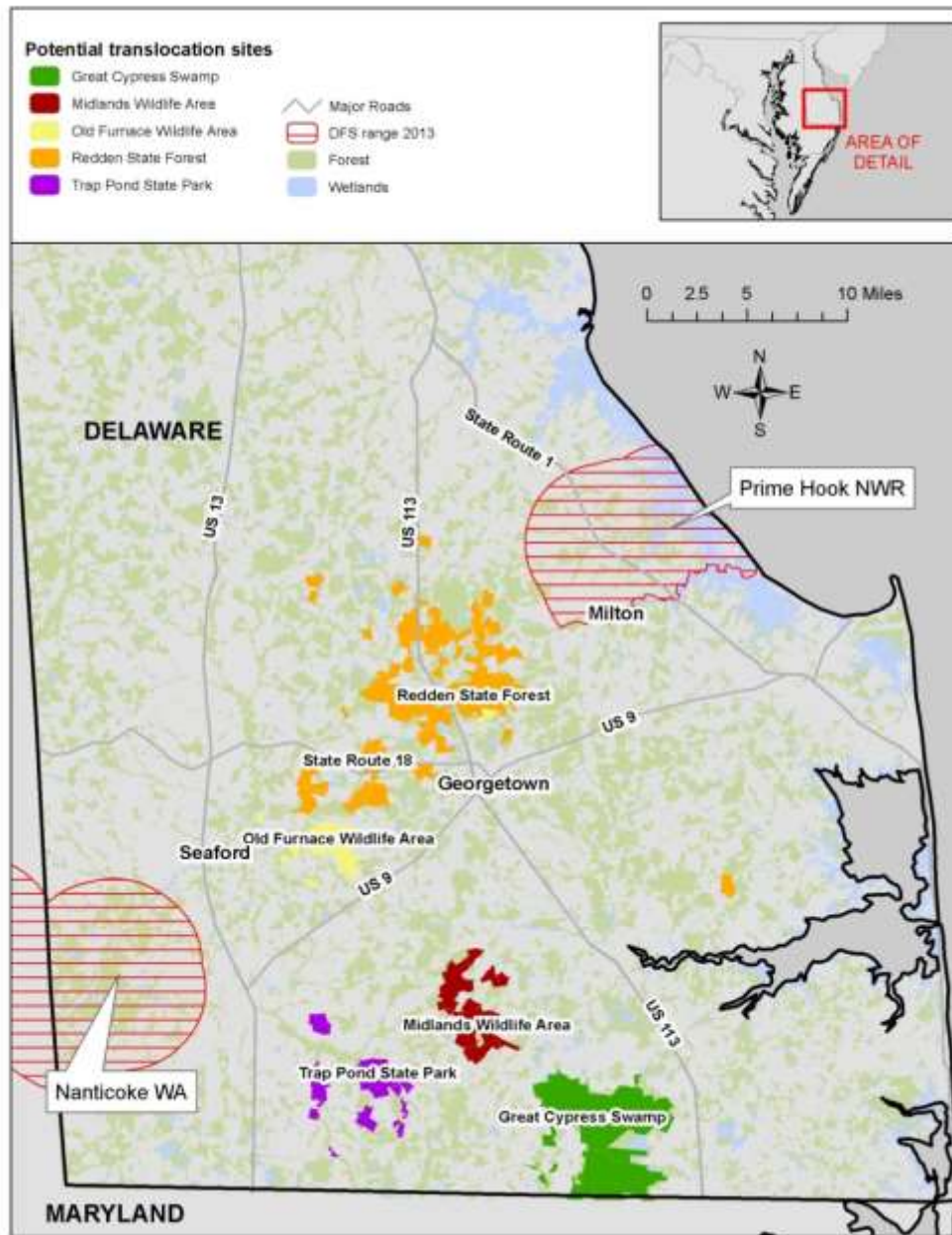


Figure 14. Potential Delmarva Fox Squirrel Translocation Sites in Sussex County, Delaware in Relation to the Existing Occupied Sites and Forest/Wetland Habitat.

Note: These are Sussex County sites with suitable sized forest blocks and are therefore candidates for translocations. No landowner permission has been sought or received for any site depicted here except Redden State Forest.

All five of these potential sites are listed as “protected lands” and appear, from a cursory GIS review, to have enough protected forest lands to support translocated squirrels. The Redden State Forest site had the most data available on its forest composition including the presence of several tracts that are greater than 40 years old, comprised of mixed hardwood species, and greater than 435 acres in size. These include the Ellendale, Headquarters, and Jester Tracts (Appendix D). There may also be additional acreage suitable for DFS e within Redden State Forest t that was acquired since the last forest assessment was completed in 2007). Overall the percentage of forested acres on Redden State Forest that is greater than 40 years old and potentially suitable for squirrel translocation was calculated at 46 percent (E. Burkentine, Delaware Forest Service, pers. comm. 2013).

The DFW’s Old Furnace WA is a planted pine plantation that was mostly harvested prior to the state’s acquisition in 2000. There are probably pines in the 40+ age class, but very few and mostly along the streams. The uplands are pine and some mixed pine/hardwood (R. Gano, Delaware DFW, pers. comm. 2013). Old Furnace WA may have been too recently harvested to be a suitable translocation site, but could be important as a habitat corridor for dispersal and genetic interchange between the Nanticoke WA and Redden State Forest should squirrels be introduced at Redden State Forest in the future.

Currently there is no age class information available for Midlands WA (E. Burkentine pers. comm. 2013), but DFW will further investigate this area as a translocation site with on-site visits. The Division of Parks and Recreation and Delaware Wild Lands, Inc. have not been contacted for forest composition information.

Interchange between squirrels may be greater between Prime Hook NWR and Redden State Forest as there is less development between those two sites (Figure 15). However, the squirrels would have to navigate State Route 1, which is a high speed four-lane road. Similarly, if interchange occurred between Nanticoke WA and Redden State Forest, squirrels would have to navigate U.S. 13 (also a four-lane road). Squirrels may also encounter more development between Nanticoke WA and Redden State Forest than other areas (Figure 15). In addition U.S. 113 (four-lane road) runs north to south through Redden State Forest (Figure 15). Great Cypress Swamp, Trap Pond State Park, and Midlands WA are potentially close enough to each other that squirrels may be able to disperse among these sites if used for translocation (Figure 14). Development, zoning, and proposed future development appear to be low between these areas (Figure 15). Redden State Forest and Great Cypress Swamp may also be appropriate for translocations as they are considered Forest Legacy Areas which the state can use certain federal funds to acquire forest conservation easements (Urban Research & Development Corporation 2008).

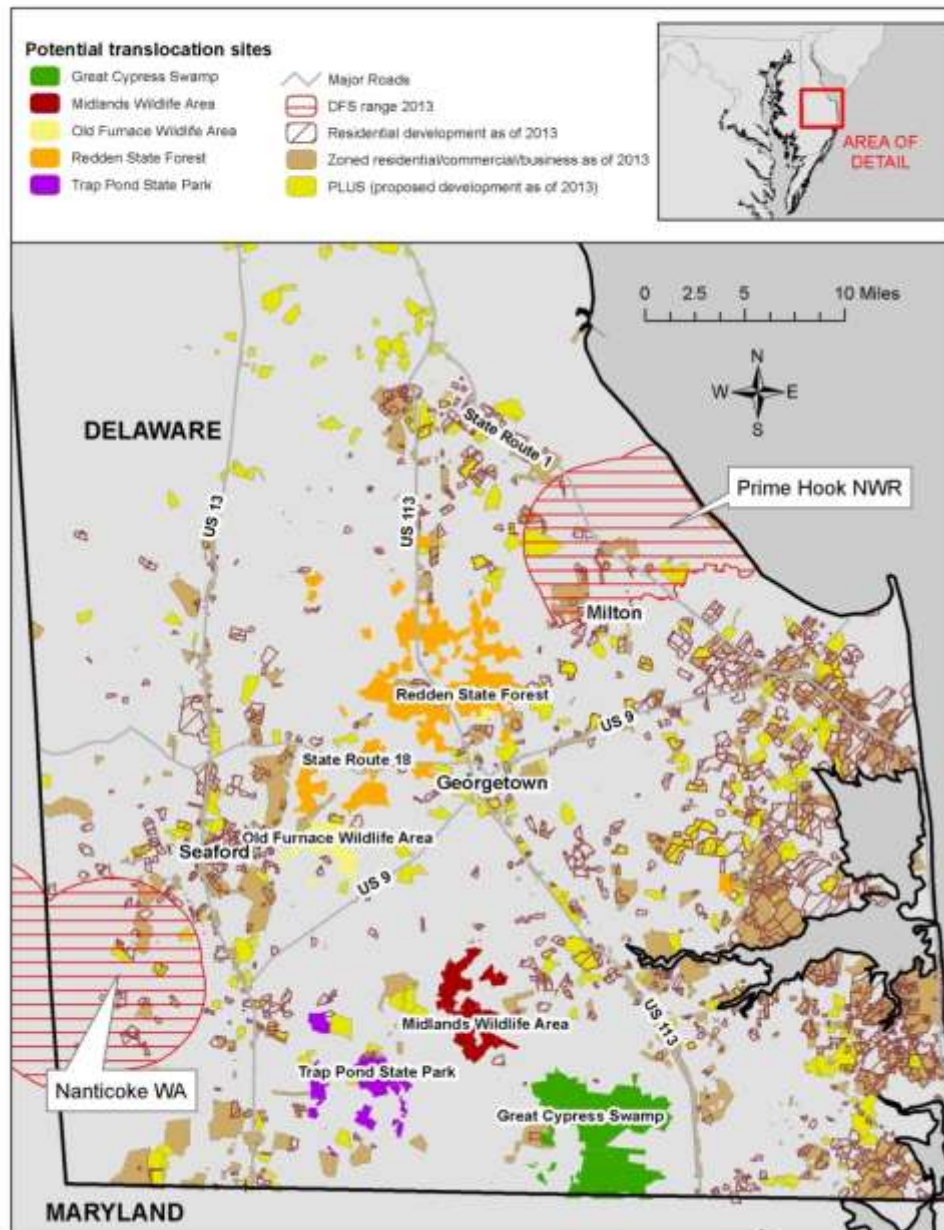


Figure 15. Potential Delmarva Fox Squirrel Translocation Sites in Sussex County, Delaware in Relation to the Existing Occupied Sites and Developed or Zoned Areas.

Note: The Preliminary Land Use Service (PLUS) Layer Includes Proposed Projects From 2004 to 2013. These are Sussex County sites with suitable sized forest blocks and are therefore candidates for translocations. No landowner permission has been sought or received for any site depicted here except Redden State Forest.

Habitat Connectivity

Habitat connectivity that allows for movement or potential dispersal of squirrels should be considered when deciding the best locations for translocations. The available forest patches between Redden State Forest and currently occupied DFS sites at Nanticoke WA and Prime Hook NWR were evaluated. A straight-line was drawn between the two most outer reaches of both sites to Redden State Forest and acreage was calculated from forest polygons within 3-mile buffers on either side of the line. Between Nanticoke WA and Redden State Forest, 256 forest patch polygons were found to encompass 10,132 acres between those sites. Between Prime Hook NWR and Redden State Forest, 66 forest patch polygons were found to encompass 7,184 acres between those two sites (Figure 16). Similarly between Nanticoke WA and Trap Pond State Park, 6,250 acres of forest were found from 204 forest patch polygons between the two sites (Figure 17). These acreage calculations may not necessarily be contiguous forest; therefore, further on-site analysis should be conducted in addition to determining ownership of the forest patches for habitat connectivity consideration.

The road system in Delaware should also be considered when evaluating the habitat for connectivity. Squirrels dispersing from Prime Hook would need to traverse State Route 1 and then possibly U.S. 113 should they disperse into Redden State Forest (Figure 16) or vice versa. Similarly, any squirrels dispersing from Nanticoke would need to traverse U.S. 13 to access Redden State Forest, Old Furnace WA, or Trap Pond State Park (Figure 17).

Once translocation sites have been determined, connecting habitats will be more closely evaluated and the DFW will reach out to landowners to provide information about the Plan, translocations, potential dispersal of squirrels and what they can do to help create or maintain connectivity if they chose to do so. As part of the implementation of this Plan, the DFW may include DFS habitat connectivity in the decision-making process when evaluating potential land or conservation easement purchases.

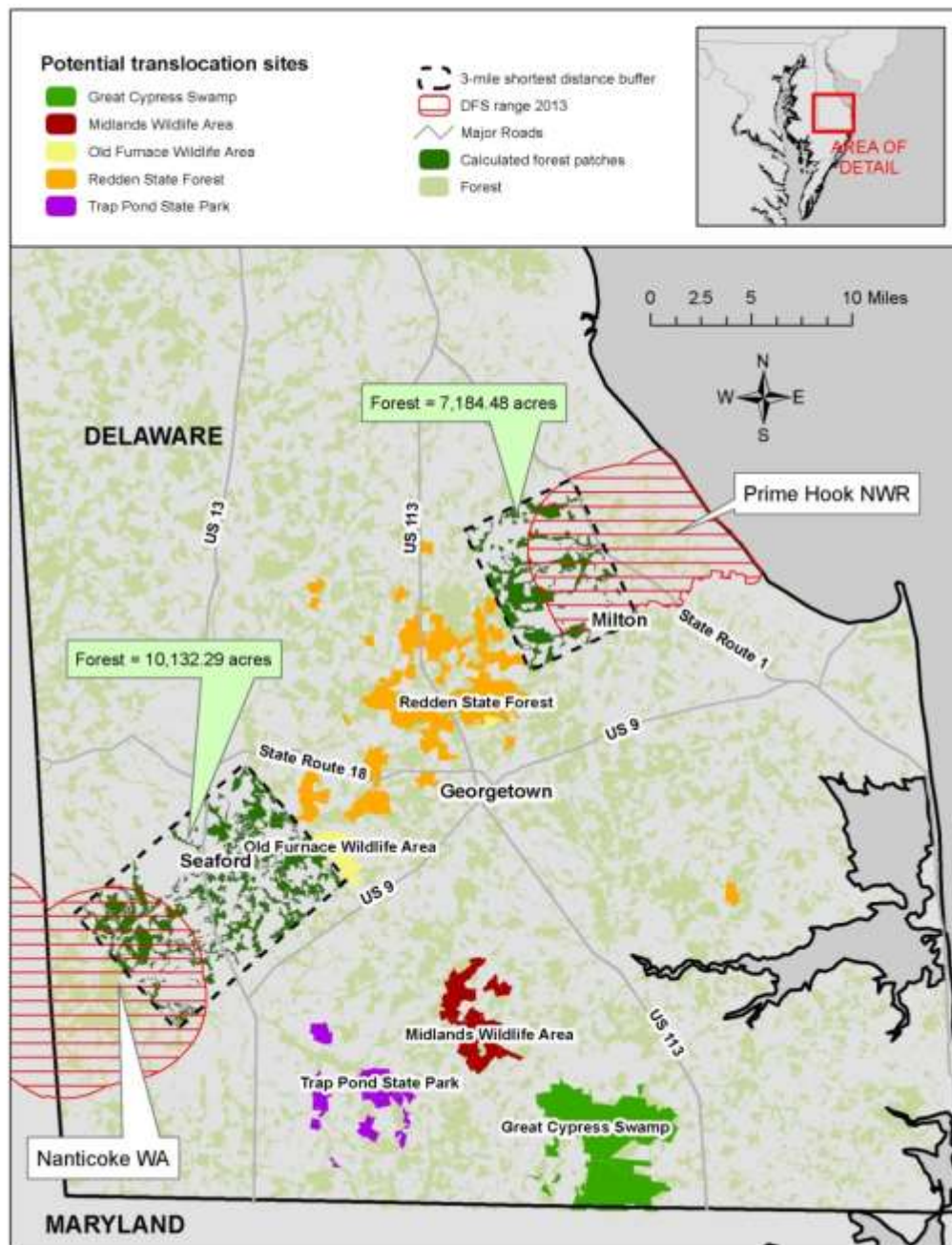


Figure 16. Forest Patches between Existing Delmarva Fox Squirrel Occupied Sites and Redden State Forest.

Note: Redden State Forest has suitable sized forest blocks and is therefore a candidate for translocations.

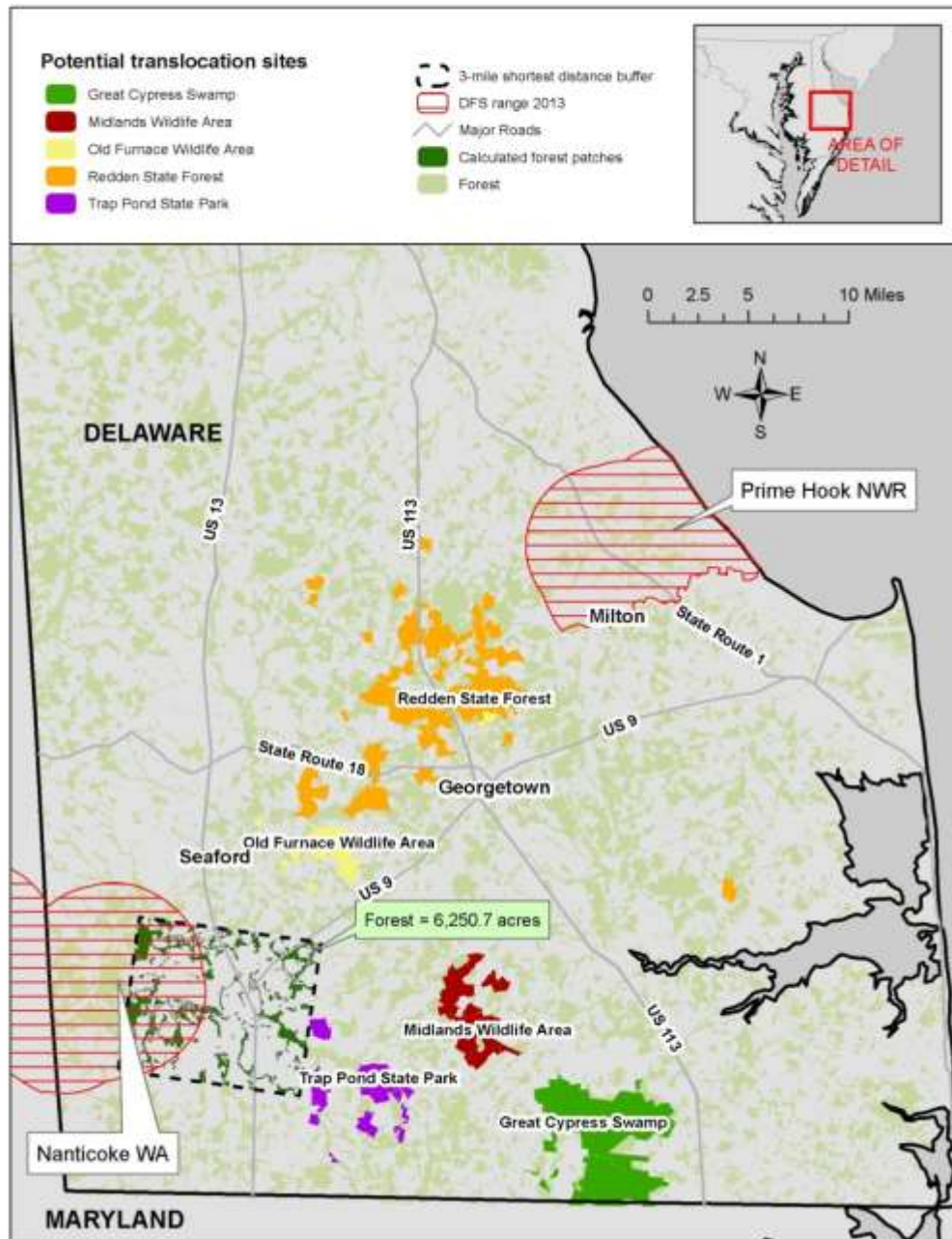


Figure 17. Forest Patches between Trap Pond State Park and Delmarva Fox Squirrel Occupied Site Nanticoke WA.

Note: Trap Pond State Park has suitable sized forest blocks and is therefore a candidate for translocations. No landowner permission has been sought or received.

Forestry

Forestland is critical to DFS survival and restoration, and working landscapes on the Delmarva Peninsula (including forestry and agriculture) are an important part of its future. The acreage of timber harvest (clearcut and selection) on the Delmarva Peninsula fluctuates from year to year, but the average harvest size in Sussex County from 1997 to 2012 has ranged from 25 to 43 acres annually (i.e. In general, the average size of forest parcels has decreased, and therefore, so have the average size of individual harvests, see *Habitat Changes Due to Agriculture and Forestry Management*).

Delaware Forest Service lands are managed to provide a mosaic of forest age classes and tree diameter distributions which can be beneficial for timber production but also provides habitat diversity that benefits wildlife as well as outdoor recreation. Planned and coordinated silviculture, including the use of DFS friendly practices, can be compatible with DFS and support viable populations. The Delaware Forest Service manages for multiple uses on its land as well as relying on its timber harvests for income. The typical “rotation age” is about 50 years or more, which provides wildlife a network of different aged forest patches, and allows it to acclimate to ever-changing surroundings.

Managing forests for DFS has been done successfully on the Delmarva Peninsula by both private and public landowners. Habitat for DFS can be improved by leaving mature and large-crowned pine and hardwood trees for squirrel nests in managed forests, encouraging nut-bearing trees in forests that have mostly pine and opening up the forest understory by burning (Chapman et al. 1982 and Engstrom et al. 1996) and thinning. Some types of disturbance in a forest are beneficial to wildlife (including DFS) and their habitat (e.g. prescribed burning).

The DFS has been shown to be flexible and is known to successfully inhabit a variety of habitats including wetland and upland forests, pine-dominated and hardwood-dominated forests, and inland and coastal areas. The most important conditions for DFS are relatively large forests (minimum of 435 acres) with closed and high canopy cover and a large proportion of trees that are 12 in. or greater dbh, typically 40 to 60 years of growth for loblolly pines. Relatively open understories are often present in DFS habitats, as they are known to spend a lot of time on the ground. Habitat diversity is also important as it provides a variety of food sources (acorns, pine cones, red maple buds, etc.) for DFS during the different seasons. They often benefit from supplemental food sources provided by nearby agricultural fields.

Forest practices can maintain the land in a forested condition suitable for DFS both spatially and temporally, as well as for other wildlife and healthy forest conditions in general. The overarching management philosophy/objective for sites managed for DFS (i.e. current sites and translocation sites) is to create a forest management program that maintains a mosaic of mature forests that will support DFS and other forest wildlife across a larger landscape.

In general, forests managed specifically for DFS should include:

- DFS friendly timber rotation and harvest practices (leave a large proportion of trees in the larger landscape that are 12 in. dbh or larger (40 to 60 year old forests in most cases).

- Harvests that leave woodland buffers for travel and movement to connect them to other nearby forest habitat.
- Forests that provide a variety of food sources with tree and shrub diversity for shelter and feeding throughout the year.
- A relatively open understory that allows the DFS movement along the forest floor. This can be accomplished by burning, thinning or understory removal by hand.
- If clearcuts are planned, make them as small as possible and scattered on the landscape to leave enough older forest for ample dispersal away from the cut area to other suitable standing forests.
- Minimal habitat disturbance from January 1 through May 15 in order to protect breeding squirrels and their young (USFWS 2006). Most of the young are born in February, March and April although there is another smaller breeding period and birth peak in July and August (USFWS 2006). Young are dependent for approximately three months (Moore 1957).

Below are *DFS Friendly Practices* to promote and protect DFS and its habitat during timber harvest. Not all of these are appropriate for every situation; this list is ideally for maximizing suitability for DFS and other forest wildlife. Forestry management decisions should be based upon the best dendrological and biological information available. The *DFS-Friendly Practices* are designed to be consistent with the mission of the DFW and Delaware Forest Service and to support national and eco-regional wildlife management objectives.

Delmarva Fox Squirrel-Friendly Practices for Forestry

Delaware Division of Fish and Wildlife 2013

General Delmarva Fox Squirrel-Friendly Practices during Timber Harvest

- Work with a Delaware State Forester or private forester to develop a forest stewardship plan that meets forest landowner objectives and be as compatible as possible with DFS management plan.
- If possible, leave blocks and/or corridors of woodlands for evicted squirrels to move to during harvests.
- Avoid timber harvests during the primary breeding season for DFS; from January 1 through May 15.
- Strive to maintain a relatively open understory.

- Strive to control exotic and invasive plant species that could degrade the natural forest health and compromise the habitat for DFS and other forest wildlife.
- Strive to conserve forested wetland habitats to provide supplemental late winter and early spring feeding habitats for DFS.
- Thinning of young forests can benefit DFS by improving the forest growth rate as well as providing a more open understory.
- Prescribed burning can benefit DFS by opening up the forest understory.
- Utilize existing landowner incentive programs such as USDA's Wildlife Habitat Incentive Program, Conservation Reserve Enhancement Program and NRCS etc. that provide financial support for many practices such as buffer planting and invasive species management.

Delmarva Fox Squirrel-Friendly Practices in Areas Where DFS Already Occur (e.g., Nanticoke WA and Prime Hook NWR) or Will be Introduced through Translocation

- Maintain mature forest suitable for DFS. Squirrels and other forest wildlife can benefit from the management of large stands (> 435 acres). Selective harvests can be used when needed.
- For sites with new translocations, do not clear cut stand where squirrels were released for a minimum of ten years (unless squirrels no longer use original woodlot).
- To maintain DFS habitat on the landscape, strive to retain individual mature stands for 20 years, with for a minimum rotation length of 60 years whenever possible.
- To maintain adequate canopy closure, strive to retain a minimum basal area of 70 to 80 sq. ft. per acre. This typically translates to large number of 12 in. or greater dbh trees.
- In thinning operations, favor retaining larger diameter trees including hardwood mast trees.
- Harvest timber (saw timber and pulpwood) when squirrels are not likely to be breeding; January 1 through May 15.
- To enhance and maintain forest connectivity for DFS and other forest wildlife, maintain a no-cut zone around riparian areas as large as possible (min. 300 ft.).
- When timber harvests are planned, strive to make clear cuts as small as possible and scattered in the landscape. Leave blocks and/or corridors of woodlands for evicted squirrels to move to during harvests.

Development

Although residential and commercial developments that permanently remove forests are generally not compatible with DFS, there are some ways to help DFS and other forest wildlife during development-related activities. These *DFS-Friendly Recommendations* for Development are not regulatory (once the DFS is federally delisted), but instead are guidance or *recommendations* for residential, commercial and industrial developments as well as supporting infrastructure construction (roads, highways and utilities). The following suggestions are provided to make building and residential areas as DFS friendly as possible.

Development Recommendations (including road work) to Benefit Delmarva Fox Squirrel

Delaware Division of Fish and Wildlife 2013

Ways to help Delmarva Fox Squirrel and their Habitat During Development Activities

- During forest clearing, try to leave the largest and most contiguous areas of mature forest intact as possible. Larger blocks of woods away from streets and wide, wooded strips that provide travel corridors for squirrels to quickly pass through the development in route to better habitats would be best for the squirrels..
- Help squirrels that are likely to be breeding and with young in the spring; from January 1 through May 15 by cutting outside of this time period.
- Try to leave as many nut and mast producing trees such as oaks, hickories, and beech as possible for squirrels as possible to support them year round.
- If it is known that squirrels are present on the site and *DFS-Friendly Recommendations* are not possible, consider allowing DFW to trap, remove and relocate squirrels prior to clearing forest.
- Consider providing wide buffers and building setbacks whenever possible to provide travel corridors as well as food and protection in and near DFS occupied areas.
- Help squirrels move throughout the landscape by retaining wooded corridors between woodlots.
- Protect squirrels, forest ecosystems and water quality by reducing run-off, sedimentation and erosion by providing the widest possible riparian buffers .
- Encourage Homeowners Associations to educate landowners about avoiding squirrel

mortality by keeping pets away from bird (and squirrel) feeders.

- At and near known DFS locations and corridors consider using signs, speed restrictions or educational efforts to inform motorists to be on the lookout for squirrels.
- At and near DFS locations and corridors consider the use of large, open box culverts when possible for new road construction or culvert repair to reduce the potential for vehicle strikes/road mortality.
- If new development is planned near DFS locations or potential travel corridors, try to minimize new road construction near woodlands as much as possible.

If a development will directly impact known DFS sites or forest corridors for squirrels, state agencies or other organizations may ask to coordinate with developers to consider conservation easements, purchase or transfer of development rights or other options that would benefit all parties.

Protection and Management of Existing Populations

Delaware DFW and potential partners will develop and maintain DFS habitat management plans for all DFS occupied sites. Delaware DFW will review this Plan every five years and update as needed with any new scientific information that becomes available. The following DFS populations will be protected and managed as follows.

Prime Hook NWR

- Conduct mark-recapture study to determine population density.
- Support implementation of Prime Hook NWR CCP (USFWS 2013).
- Meet periodically (every two to five years) with Prime Hook NWR to coordinate and work to incorporate state-wide objectives and *DFS-Friendly Practices* identified in this Plan.
- Consult with Prime Hook NWR on an annual basis to develop annual plans and objectives based on current or new data which can be included in future CCPs.
- Coordinate with willing adjacent forest landowners with DFS habitat to increase landowner awareness and promote habitat management on adjacent lands.
- Work with Prime Hook NWR to develop research projects based on existing questions or objectives for DFS.

Nanticoke WA

- Conduct mark-recapture study to determine population density.
- Update the Wildlife Management Plan as needed (Gano 1991) or the Annual Work Plan to sustain and increase suitable habitat for DFS and address the objectives contained in this Plan.
- Incorporate the *DFS-Friendly Practices* in this Plan for forestry, surveys and disturbance and conservation measures.
- Monitor DFS in accordance with the USFWS' *Post-Delisting Monitoring Plan*. If any translocations occur, they will be done so in accordance with the *Draft Translocation Plan*.
- Use PVA modeling data to set DFS population objectives, refine objectives as new data becomes available and provide for habitat management in defined areas (clearing understory and not harvesting some areas) for the long-term viability of DFS. Site visits will be needed to accurately assess the current habitat at Nanticoke WA.
- Meet periodically (every two to five years) with WA Managers to review and/or develop plans and objectives based on current or new scientific data.
- Increase the hunter education program on this WA to avoid incidental take of DFS since gray squirrel hunting is not prohibited. Consider conducting regular bag checks and/or hunter encounter and mail-in surveys to determine if DFS are accidentally being taken by hunters. Consider closing squirrel hunting if warranted.

Assawoman WA

- Delmarva fox squirrels were translocated from Maryland to Assawoman WA in 1984 (seven squirrels) and 1985 (six squirrels). The animals were regularly seen on site until the late 1990s, after which time trapping and nest box checks did not result in verification. Efforts to document their presence from 2003 to 2005 with trapping and photomonitoring were not successful and the USFWS classified it as a failed translocation site. The reason this population died out after over a decade is unclear. However, this was one of the first translocations completed and it received far fewer squirrels than most. The recommended number is 24 to 30 and this translocation only included 13 animals. Trapping never resulted in more than four squirrels captured in a given year, indicating the population may have never reached a sustainable level.

- Attempts at another translocation at this site are a possibility, but development pressure and connectivity need to be considered. Discuss the pros and cons of future translocations at this site.

Landowner Coordination

With the conservation of any species, the importance of communication with the managing agency and private/public land managers and owners is key to the success of implementing conservation practices. It is the Delaware's DFW desire to work with willing landowners who are interested in the Plan and its objectives with transparent communication and participation to restore DFS in Delaware without inconveniencing those interested, economically or otherwise. In Maryland, many DFS occur on lands which are privately owned and DFS translocations on these properties are completely voluntary.

Land managers/agencies who wish to accept translocated squirrels on their lands will work with DFW to develop and implement a site specific MOU that will include guidelines for habitat retention and management, survey needs and long-term goals. ***Landowners adjacent to translocation or currently occupied sites will not be required to do anything.*** Land use will not be restricted if DFS move off the translocation sites and onto private lands. However, the DFW will seek out partnership opportunities to extend the effectiveness of this Plan beyond the boundaries of the occupied and translocation sites. Willing landowners near occupied or translocation sites may be encouraged to consider DFS-friendly conservation measures. Below are *DFS-Friendly Practices* for ***willing landowners*** under different land management scenarios.

Prior to translocations, the DFW and/or the entity accepting the new squirrels, will conduct a workshop for area landowners to ensure they understand the conservation goals and how the addition of the squirrels will impact them. Or, more accurately, *not* impact them. Letters and/or phone calls may be used to communicate to landowners that cannot attend the workshop.

Delmarva Fox Squirrel-Friendly Practices for Landowners

Delaware Division of Fish and Wildlife 2013

Willing Landowners Who Are Interested in Encouraging DFS on Their Property

The primary goals for landowners who are interested in encouraging DFS on their property should be to strive to avoid short-rotation timber harvests, maintain or plant wider riparian forest buffers and consider implementing **Forestry and/or Development DFS-Friendly Practices included in this Plan as appropriate.**

- If timber harvests are planned, willing landowners are encouraged to meet with State Foresters to develop a forest stewardship plan that will address the landowner's objectives for managing their forest while encouraging DFS on their property (if possible) and any other objectives the landowner is considering.
- For areas between occupied sites and potential habitat, landowners can assist with DFS dispersal by maximizing the amount of stream and wetland buffers and connectivity corridors.
- Work to keep domesticated pets in fenced areas away from bird or squirrel feeders or known DFS den trees as DFS can be easy prey for cats and dogs.

Landowners Adjacent to Future DFS Translocation Sites

- There will be no requirements should DFS come onto the property adjacent to translocation sites. However, we encourage all willing landowners to implement *DFS-Friendly Practices* whenever possible.

Update State, Federal Plans and Site Plans to Include Management for DFS

Delaware WAs managers should consider updating WA management plans (or Annual Work Plans) to take DFS into account within the broader context of those plans, especially at Nanticoke WA. Future potential DFS translocated population sites will also require the incorporation of this Plan into appropriate documents. These management plans should incorporate this Plan and the most current scientific information available. The DFW will develop a schedule and program leading to the completion and updates of these management plans. Prime Hook NWR completed their CCP in 2013 (USFWS 2013) and currently has appropriate measures for the conservation and protection of DFS and its habitat on the refuge. The DFW will encourage Prime Hook NWR to reference this plan when the 2013 CCP is up for renewal (five years) and to incorporate it into any of its appropriate step down plans, including its Habitat Management Plan as they are developed and updated.

Additional Monitoring

In order to monitor the progress of the DFS biological goals the following activities may need to be conducted on a regular basis:

- Acres cleared or degraded on the WAs that have DFS or are candidate sites for translocations may be tracked with GPS/GIS.
- Acres of land conversion from forest to agricultural, development or clearcut timber harvests in core habitats or dispersal corridors may be monitored.
- Acres of newly occupied habitat may be monitored through trapping, cameras, hair catchers or a combination of techniques.

Post-Delisting Monitoring Plan

The two key variables that have been the focus of DFS monitoring since it was federally listed are 1) the distribution of DFS populations, including the overall size of the range, and 2) the persistence of populations within the range (USFWS 2012). Monitoring the distribution of this species and insuring its persistence on the landscape have been the primary goals of the monitoring program and will continue after delisting (USFWS 2012). Monitoring the distribution of DFS can be challenging. The squirrels are quiet, secretive, and cannot be readily observed in a casual walk through the woods or a line-transect (Paglione 1996) which creates some difficulties for monitoring. They do not vocalize frequently and remain quiet and hidden most of the time (USFWS 2012).

The two main goals of the USFWS' *Post-Delisting Monitoring Plan* are as follows:

- Map the distribution of the DFS to determine the overall size and distribution of the DFS range and quantify the total acres and number of occupied forest tracts.

- Monitor persistence of DFS within the range by re-assessing DFS occupancy in a sample of occupied forest tracts to estimate the relative proportion that demonstrate persistence versus extirpations.

During the Post-Delisting Monitoring Period, the USFWS and the Recovery Team will annually conduct a review of the monitoring data and monitoring program. The USFWS will consider various relevant factors (including but not limited to mortality rates, population changes and rates of change, disease occurrence, and range expansion or contraction) to determine if the population of DFS warrants expanded monitoring, additional research, and evaluation of protection. At the end of the 5-year Post-Delisting Monitoring Program, the USFWS will conduct a final review.

Surveys and Monitoring of Existing Populations

In order to update the status and distribution of DFS in Delaware, additional survey and monitoring work are needed; including trapping at Prime Hook NWR and additional camera work and trapping at Nanticoke WA in 2014 or 2015.

Delaware DFW will coordinate with the USFWS Chesapeake Bay Field Office to consider implementing improved DFS monitoring techniques, such as motion-activated cameras, trapping, and nest box checks, as included in the *Post-Delisting Monitoring Plan*.

Education and Outreach Campaign

Education and outreach are vital to any conservation plan and are an important component of this Plan. Strategies for hunter education, landowner outreach, public awareness and working with partners are outlined below.

Hunting

Inappropriate hunting and fishing was identified in the Delaware WAP as a specific issue for the Coastal Plains Upland Forest Key Habitat Type (DNREC 2006). This Plan incorporates specific actions addressed in the Delaware WAP and additional actions developed for this Plan for hunter education.

- Develop education and outreach strategies that provide information to hunters about DFS in order to minimize the possibility of an accidental killing. The DFW will obtain or produce a short video of DFS highlighting the differences between DFS and common gray squirrels.
- Develop a module on DFS and common gray squirrels for the DFW Hunter Education Program.
- Delaware DFW will explore adding an education component that is associated with on-line hunter registration.

- Continue education and outreach with readily available signs (including weather-proofed interpretive signs), posters, or ID cards with photos and descriptions of DFS and the differences compared to a common gray squirrel.
- Strengthen enforcement of existing hunting and trapping regulations.
- Conduct surveys with hunters to determine effectiveness of education efforts regarding identification of DFS and common gray squirrel. Surveys would be written, on-line or encounter surveys with hunters during the small game season. Delaware DFW will attempt to recruit a minimum of ten percent of hunters for surveys.
- Create an incentive program to encourage hunters to report DFS sightings.
- Incorporate information about SGCN conservation into the DFW's Hunting and Trapping Guide.
- Maintain compliance with any federal regulations.

The DFW previously included the necessary information to distinguish the common gray squirrel from DFS in the Delaware Hunting and Trapping Guide in 2013 and will continue this in subsequent years to minimize the possibility of accidental take. The DFW will redesign and post hunter posters at all locations where DFS occur (Nanticoke WA and Prime Hook NWR), others as reported) and at Ommelanden Hunter Education and Training Center (New Castle County), Owens Station (Sussex County), Cedarfield Ruritan Club (Kent County), C&R Center - Norman G. Wilder WA (Kent County) and any other hunting related facilities/WAs to maximize visibility (Figure 18). The DFS information will also be available at the Office of Hunter Education in Smyrna, Delaware. The Delaware Hunter Education Program requires anyone born after January 1, 1967, to satisfactorily complete a Basic Hunter Education Course before obtaining a Delaware hunting license. The Hunter Education Program Coordinator will work with DFW to offer information about SGCN, specifically DFS, during these basic classes (M. Ostroski, Delaware Office of Hunter Education, pers. comm. 2013).

ATTENTION HUNTERS

..... Look CLOSELY Before Shooting

Gray Squirrel



- **FUR:** Darker gray with rusty brown highlights
- **EARS:** Longer and pointy
- **BELLY:** White
- **SIZE:** Smaller with less bushy tail

Delmarva Fox Squirrel



- **FUR:** Silver gray with creamy to white belly, ears and muzzle.
- **EARS:** Shorter and wider
- **BELLY:** Creamy white
- **SIZE:** Larger with fuller tail

Sussex County hosts two species of diurnal tree squirrel: Gray and Delmarva Fox. *Gray squirrels* are quite common while *Delmarva fox squirrels* are so rare they are on the federal Endangered Species list.

If you hold a Delaware hunting license, you are permitted to hunt *gray squirrels* but **NOT fox squirrels**. So, before you shoot, take a close look at the squirrel in your crosshairs.



IF YOU SEE A DELMARVA FOX SQUIRREL: Please fill out a sighting form, inform Wildlife Area manager, or call the Natural Heritage office (302-653-2880). **THANKS!**

Figure 18. Delaware Division of Fish and Wildlife Hunter Poster Highlighting the Difference between the Common Gray Squirrel and the Delmarva Fox Squirrel.

Landowner Outreach

Delaware DFW will seek partnership opportunities with landowners and developers in support of implementing the objectives and *DFS-Friendly Recommendations or Practices* of this Plan on a landscape scale. Formal coordination agreements may be drafted with willing participants to commit signatories to a long-term course of action towards fulfilling the biological goals set forth in this Plan. Other partnering efforts with landowners may include but are not limited to:

- Joint efforts in surveying, monitoring, and management responsibilities.
- Coordinated efforts in biological data management.
- Public information, outreach and environmental education efforts and materials.
- Matching or other shared funding for land acquisitions and/or conservation easements.
- Coordination and use of local contributions, including land, trusts, volunteer support, and other in-kind services.
- Shared equipment.

Delaware DFW will develop a management guidelines reference for use by developers, landowners and other interested parties. Delaware DFW will meet with these individuals to discuss implementation of the plan and offer any new scientific information that becomes available on DFS and its suitable habitat.

Delaware DFW will ensure that all requirements for translocations, MOUs, and other agreements are met (i.e., *DFS-Friendly Practices* will be implemented, any *take* will be incidental, impacts will be minimized to the maximum extent practicable and that other agreements are honored).

Public and Other Partner Outreach

Delaware DFW will continue to foster the public's participation in the implementation of the Plan in order to maintain the public's support and trust as it is vital to DFW's ability to fulfill the commitments in this Plan. This degree of support also translates into public accountability, which establishes the public as a steward to monitor DFW's implementation of the Plan. Examples of public participation endeavors that DFW will pursue include, but are not limited to: public outreach, site stewards and collaborative partnering for DFS (Figure 19).



Figure 19. Delmarva Fox Squirrel. © Wil Hershberger

Public Outreach

Presentations will be developed to share information at public or special interest group meetings to report on the Plan and the progress in implementation. Reports or newsletters, a website and social media (e.g., Facebook, Twitter) may be used to communicate the status and progress of DFS in Delaware. Delaware DFW will coordinate with the USFWS to explore the possibility of installing a webcam into a nest box for DFS. When the nest box is occupied, the DFW may be able to broadcast the live video feed on DFW's website.

Site Stewards

Delaware DFW may establish a site steward program using citizen volunteers to aid in periodically visiting conservation properties to monitor squirrels for signs of stress and activities that may adversely impact DFS resources. Site stewards may also engage in routine maintenance activities such as helping keep the area clean if it is a human use area or checking on any site-cameras that may be installed.

Collaborative Partnering

Many of the environmental issues facing the management of conservation lands under the Plan are complex and transcend political boundaries and ownership categories, making it essential for DFW to work with its neighbors and other interested entities. Delaware DFW anticipates collaborative partnerships on specific issues with various NGOs, land resource management agencies, and multi-disciplinary groups such as the cooperative ecosystem study units.

Delaware's existing conservation delivery system provides viable opportunities for integrating DFS conservation and this Plan into existing mechanisms and infrastructure for future, long-term DFS recovery in Delaware. The following agencies and organizations are potential participants for implementing this Plan. They may also act as partners by incorporating DFS information and this Plan into their existing programs with possible funding and implementation incentives.

The DFW may pursue partnering opportunities with common goals for biological conservation with this Plan's stakeholders and other interested parties.

- USFWS Chesapeake Bay Field Office, NWRs, Delaware Estuary Program Office
- Department of Agriculture – Delaware Forest Service
- DNREC – Land Use and Delaware Division of Parks and Recreation
- Delaware Coastal Program
- Forest Legacy Program, Delaware Forest Service
- NRCS
- Sussex County Planning and Zoning
- Center for the Inland Bays
- Sussex County Land Trust
- Delaware Nature Society
- The Nature Conservancy, Delaware Field Office
- The Conservation Fund
- Delaware Wild Lands, Inc.
- Environmental Defense
- Universities
- Positive Growth Alliance
- Sediment Control and Stormwater Management Program, DNREC
- Environmentally Sensitive Areas Certified Construction Review Program in Sussex County
- Amelia Wright, Otis Clifton, Delaware Landowners
- Maryland Department of Natural Resources
- Maryland Forest Service

Depredation and Disease Management

Depredation and disease have not been identified as significant threats to DFS in the past 40 years (Figure 20); therefore, is currently not considered a threat to the species (USFWS 2012). However, unforeseen depredation and disease (e.g. white nose syndrome in bats) that could

impact DFS may become an issue in the future and would be managed accordingly to ensure long-term survival of DFS in Delaware.

The DFW will evaluate effects of known depredation of squirrels by tracking events and possibly monitoring predator populations if necessary. Squirrels will also be monitored for signs of disease during trapping and telemetry studies. Specific research may be conducted by university or independent researchers to address predation and disease. The Delaware DFW will collaborate with researchers if such studies are conducted.



Figure 20. Cooper's Hawk with Young Delmarva Fox Squirrel as Prey.
© Wil Hershberger.

RESEARCH

Delaware DFW will collaborate with the USFWS, other state agencies, private and public landowners, NGOs and universities in order to maximize effectiveness of research efforts pertaining to the goals/objectives of this Plan. Research techniques could include camera studies to help determine distribution and dispersal, telemetry for translocation effectiveness and dispersal, mark/recapture for population studies as well newer technologies such as hair catchers,

LIDAR and other techniques and technologies as they are developed. Most initial research efforts will focus on population status questions and effectiveness of translocation efforts but other research questions may be explored as the answers can inform future management decisions and actions.

- Were the translocations effective?
- Did DFS move off primary woodlands and, if so, where did they move to and what was the rate of dispersal?
- What are the limiting factors for DFS population growth and persistence?
- What is the genetic diversity of the translocated and native populations in Delaware? May use collection of DFS hair for DNA analysis.
- What is the population size, sex ratios and reproductive rates of translocated and native squirrels? May be answered with monitoring existing populations and future translocated populations using trapping, nest boxes, and infrared cameras.
- Are there ways to effectively reduce road kill of DFS?
- How can hunters, landowners and volunteers best assist with data collection?
- Do DFS and common gray squirrels compete for resources or is the dynamic between the species dictated more by habitat or other resource needs?
- Does depredation by natural predators (e.g. hawks, fox, and coyote) limit or otherwise effect population growth in some areas? If so, what management strategies could be used in these areas?
- Would specialized methods such as artificial food trays be effective to monitor predation or other research questions?

ADAPTIVE MANAGEMENT

Specific descriptive or prescriptive habitat management requirements for DFS are still the subject of considerable scientific scrutiny. Therefore, forest land managers should expect that the demonstrated preference or acceptance by DFS for habitats created on the forest may determine future habitat management considerations. While the *recommended DFS- Friendly Practices* provided in this document represent the best science available, *DFS-Friendly Practices* may be adjusted as more is learned of the species. Monitoring of DFS populations and habitat use is critical to successful long-term planning.

Scenarios and Preparing For Possible Population Stressors

For the purposes of this Plan, “unforeseen circumstances” are those potential population stressors or events that are not being planned for in this document which could significantly change the circumstances associated with DFS and this Plan and may include: natural catastrophic events such as fire, drought, severe wind or water erosion, floods, and hurricanes of a magnitude exceeding that expected to occur during the life of this Plan.

- Invasion by exotic species, habitat, or species-specific disease that threaten DFS or its habitat which cannot be effectively controlled by currently available methods or technologies or which cannot be effectively controlled without resulting in greater harm to other species than to the affected DFS.
- Climate change/sea level rise that is greater from what is currently predicted.

LITERATURE CITED

References

Allen, G.M. 1942. Extinct and vanishing mammals of the Western Hemisphere, with the marine species of all the oceans. American Committee for International Wild Life Protection, Special Publication. 11 pp.

Allen, A.W. 1982. Habitat suitability index models: Fox Squirrel. FWS/OBS-82/10.18. U.S. Department of the Interior, Fish and Wildlife Service. Washington, D.C. 11 p.

Barkalow, F.S., Jr. 1956. Sciurus niger cinereus Linne neotype designation. Proceedings of the Biological Society of Washington 69: 13-20.

Bocetti, C.I. and O.H. Pattee. 2003. Presentation to the DFS Recovery Team. August 11-12, 2003. Provided by Cherry Keller, U.S. Fish and Wildlife Service, Cheseapeake Bay Field Office.

Braun, E.L. 1950. Deciduous Forests of Eastern North America. The Blakiston Co., Philadlephia, Pennsylvania. 596 pp.

Brown, L.G. and L.E. Yeager. 1945. Fox Squirrels and Gray Squirrels in Illinois. Illinois Natural History Survey Bulletin 23: 449-536.

Chapman, J.A. and G.A. Feldhamer, eds. 1982. Wild Mammals of North America. Baltimore, MD: The Johns Hopkins University Press. 1147 pp. (*in*: The Effects of Hazard Reduction Burns in Mid-Atlantic Coastal Plain Forests: Draft Proposal).

Delaware Department of Natural Resources and Environmental Control. 2006. Delaware Wildlife Action Plan 2007 – 2017. 222 pp.

Delaware Division of Fish and Wildlife Delaware Hunting Guide. 2013. 44 pp.
http://www.eregulations.com/wp-content/uploads/2013/07/13DEHD-FINAL_LR.pdf

Delaware Forest Service Strategy. 2010. Report to the U.S. Forest Service. 40 pp.

Delware Forest Service Resource Assessement. No date (n.d). 84 pp.

Delaware Office of State Planning, Coordination. 2012. 2012 Report on State Planning Issues. 56pp.
http://www.stateplanning.delaware.gov/docs/2012_cabinet_committee_annual_report_final_11_01_2012.pdf

Delaware Office of State Planning, Development Trends. 2013.
http://www.stateplanning.delaware.gov/information/development_trends.shtml

Delaware Population Consortium. 2005. Annual Population Projections. Dover, Delaware.

Delaware Population Consortium. 2012. Annual Population Projections. Dover, Delaware.
<http://www.stateplanning.delaware.gov/information/dpc/DPC2012v1.0.pdf>

Dozier, H.L. and H.E. Hall. 1944. Observations on the Bryant fox squirrel. *Sciurus niger bryanti* Bailey. Maryland Conservation 21: 2-7.

Dueser, R.D. 1999. Analysis of Delmarva fox squirrel (*Sciurus niger cinereus*) benchmark population data (1991-1998). Report to USFWS, Chesapeake Bay Field Office, Annapolis, Maryland. Contract 5141070512A.

Dueser, R.D. 2000. A review and synthesis of habitat suitability modeling for the Delmarva fox squirrel (*Sciurus niger cinereus*), with a proposal for future conservation planning. Report to Delaware Bay Estuary Project, U.S. Fish and Wildlife Service. Contract number: 51120-7-0085a. 66 pp.

Dueser, R.D., J.L. Dooley, Jr., and G.J. Taylor. 1988. Habitat structure, forest composition and landscape dimensions as components of habitat suitability for the Delmarva fox squirrel. Pp. 414-421 in R.C. Szaro, K.E. Severson, and D.R. Patton (eds.), Management of amphibians, reptiles and small mammals in North America. U.S. Forest Service Technical Report RM-166.

Engstrom, R.T., McNair, D.B., Brennan, L.A., Hardy, C L. and L.W. Burger. 1996. Influence of dormant versus lightning season prescribed fire on birds in longleaf pine forests: experimental design and preliminary results. Transactions of the North American Wildlife and Natural Resources Conference. 61: 200 - 207.

Gano, R.D. Jr. 1991. Wildlife Management Plan For Robert L. Graham Nanticoke Wildlife Area. Prepared for Delaware Division of Fish and Wildlife and Delaware Fish and Game Advisory Council. 79 pp.

Hall, E.R. 1981. The mammals of North America. Second. ed. John Wiley and Sons, New York. 1: 1-606 + 90 pp.

Handley, C.O., Jr. and C.P. Patton. 1947. Wild mammals of Virginia. Virginia Commission of Game and Inland Fisheries, Richmond, Virginia.

Handley, C.O., Jr. and L.K. Gordon. 1979. [Accounts of various species of mammals.] in D. W. Linzey (ed.), Endangered and threatened plants and animals of Virginia. Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Harnishfeger, R.L., Rosebury J.L. and W.D. Klimstra. 1978. Reproductive levels in unexploited woodlot fox squirrels. Transactions of the Illinois State Academy of Science 71: 342-355.

Hilderbrand, R.H., R.H. Gardner, M.J. Ratnaswamy, and C. E. Keller. 2004. Demographic analysis and estimates of extinction risk for the Delmarva fox squirrel. Report in fulfillment of National Fish and Wildlife Foundation project # 1999-0368-013 and U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD. 41pp.

IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Larson, B.J. 1990. Habitat utilization, population dynamics and longterm viability in an insular population of Delmarva fox squirrels (*Sciurus niger cinereus*). M.S. Thesis, University of Virginia. Charlottesville, Virginia.

Loeser, L.J. and C.I. Bocetti. 2009. California University of Pennsylvania Student Chapter conducts monitoring study for endangered Delmarva fox squirrel recovery program poster. The Wildlife Society's 16th Annual Conference, Monterey, California, September 20-24.

Mansueti, R. 1952. Comments on the fox squirrels of Maryland. Maryland Naturalist 22: 30-41.

Maryland Department of Natural Resources Forest Service. Accessed 2013. Forest Health Report. <http://www.dnr.state.md.us/forests/healthreport/>

McAvoy, W.A., P.J. Bowman, and K.A. Bennett. 2006. Delaware Forest Habitat-quality Assessment: Coastal Plain Forests on Private Lands Final Report. Delaware Department of Natural Resources and Environmental Control, Delaware Division of Fish and Wildlife, Natural Heritage & Endangered Species Program. 125 pp.

McCloskey, R.J. and P.A. Vohs Jr. 1971. Chronology of reproduction of the fox squirrel in Iowa. Proceedings of the Iowa Academy of Science 78: 12-15.

Moncrief, N.D., J.B. Lack, and R.A. Van Den Bussche. 2010. Eastern fox squirrel (*Sciurus niger*) lacks phylogeographic structure: recent range expansion and phenotypic differentiation. Journal of Mammalogy, 91(5): 1112-1123.

Moore, J.C. 1957. The natural history of the fox squirrel, *Sciurus niger shermani*. Bulletin of the American Museum of Natural History 113: 1-71.

Morris, C.M. 2006. Building a predictive model of Delmarva fox squirrel (*Sciurus niger cinereus*) occurrence using infrared photomonitoring. MS. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 132 pp.

New Jersey Department of Environmental Protection (NJDEP). Accessed 2013. Forest Facts. http://www.state.nj.us/dep/parksandforests/forest/iyof_facts.html.

Olstein, F. and T. Koziol (eds.). 1989. Audubon's wildlife: the quadrupeds of North America. Longmeadow Press, Stamford, Connecticut.

Paglione, L.J. 1996. Population Status and Habitat Management of Delmarva Fox Squirrels. Masters of Science Thesis University of Massachusetts Amherst. 122 pp.

Poole, E.L. 1932. A survey of the mammals of Berks County, Pennsylvania. Reading Museum and Art Gallery Bulletin No. 13, Reading, Pennsylvania.

Poole, E.L. 1944. The technical names of the northeastern fox squirrels. Journal of Mammalogy 25: 315-317.

Rhoads, S.N. 1903. The mammals of Pennsylvania and New Jersey. Privately published, Philadelphia, Pennsylvania.

Taylor, G.J. 1973. Present Status and Habitat Survey of the Delmarva Fox Squirrel (*Sciurus niger cinereus*) with a Discussion of Reasons for its Decline. Proceedings of the Southeastern Association of Game and Fish Commissions 27: 278-289.

Taylor, G. J. 1976. Range Determination and Habitat Description of the Delmarva Fox Squirrel Maryland. M.S. thesis, University of Maryland, College Park, Maryland. 76 pp.

Terwilliger Consulting Inc. 2012. Forest Stewardship Plan for the Delmarva Fox Squirrel on Virginia's Eastern Shore Private Landowner Plan Template. Prepared for the Virginia Department of Game and Inland Fisheries. 38 pp.

Urban Research & Development Corporation. 2008. Sussex County Comprehensive Plan Update. 2006 pp.

U.S. Department of Agriculture (USDA), Forest Service. 2009. Forests, Water, and People – Drinking water supply and forest lands in Delaware. 9pp.

USDA. Accessed 2013. Urban Trees Store Carbon, Enhance the Environment, Provide Economic Benefits. <http://blogs.usda.gov/2013/05/09/urban-trees-store-carbon-enhance-the-environment-provide-economic-benefits/>.

U.S. Environmental Protection Agency. 2012. The Economic Benefits of Protecting Healthy Watersheds Factsheet. 4 pp.

U.S. Fish and Wildlife Service (USFWS). 1993. Delmarva fox squirrel (*Sciurus niger cinereus*) recovery plan, second revision. Prepared by Delmarva fox squirrel recovery team for Northeast Region, U.S. Fish and Wildlife Service, Hadley, Massachusetts. 69 pp. plus appendices.

USFWS. 2003. Status and recovery plan update for the Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*). U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, Maryland. 58 pp.

USFWS. 2006. Interim five-year review guidance. Accessed from USFWS intranet site on November 9, 2006. (As Cited in Terwilliger Consulting Inc. 2012).

USFWS. September 2006. Chesapeake Marshlands National Wildlife Refuge Complex Comprehensive Conservation Plan. 231 pp. +Appendices.

USFWS. 2007. The Delmarva Peninsula Fox Squirrel (*Sciurus niger cinereus*): 5-year Status Review. Chesapeake Bay Field Office. Annapolis, Maryland. 52 pp.

USFWS. 2008. Delmarva Peninsula Fox Squirrel *Sciurus niger cinereus* Factsheet. 2pp.

USFWS. 2012. Delmarva Peninsula Fox Squirrel (*Sciurus niger cinereus*) 5-Year Review: Summary and Evaluation. Chesapeake Bay Field Office. Annapolis, Maryland. 102 pp.

USFWS. 2013. Prime Hook National Wildlife Refuge Comprehensive Conservation Plan. 1059 pp.

Virginia Comprehensive Conservation Strategy. 2005. Appendix J. Research and Monitoring Needs Identified by the Taxonomic Advisory Committees. 8 pp.

Weber, T.C. 2007. Development and application of a statewide conservation network in Delaware, U.S.A. *Journal of Conservation Planning* 3: 17-46.

Weigl, P.D., M.A. Steele, L.J. Sherman, J.C. Ha, and T.S. Sharpe. 1989. The ecology of the fox squirrel (*Sciurus niger*) in North Carolina: implications for survival in the Southeast. *Bulletin of the Tall Timbers Research Station*. 93 pp.

Personal Communication

Burkentine, Erich, Southern Regional Forester/Regional Fire Management Officer. 2013. Delaware Forest Service.

Gano, Robert, Regional Fish & Wildlife Manager. 2013. Delaware Division of Fish and Wildlife.

Keller, Cherry, Endangered Species Biologist. 2013. U.S. Fish and Wildlife Service Chesapeake Bay Field Office.

Love, Susan, Planner IV. 2013. Delaware Coastal Programs.

Ostroski, Mark C., Delaware Hunter Education Coordinator. 2013. Office of Hunter Education.

Pritchett, Timothy M., Sergeant. 2013. Delaware Division Fish and Wildlife Enforcement.

Rogerson, Joseph, Deer and Furbearer Biologist. 2013. Delaware Division of Fish and Wildlife.

APPENDIX A:

Species of Greatest Conservation Need to benefit from the Protection of Delmarva Fox Squirrel (Derived from Delaware Wildlife Action Plan 2006)

Coastal Plain Upland Forests (Tier 1 SGCN)

Scientific Name

Common Name

Insects

<i>Cicindela patruela consentanea</i>	Northern barrens tiger beetle
<i>Callophrys irus</i>	frosted elfin
<i>Catocala antinympha</i>	sweetfern underwing
<i>Catocala lacrymosa</i>	tearful underwing

Reptiles

<i>Terrapene carolina</i>	Eastern box turtle
<i>Eumeces laticeps</i>	broadhead skink
<i>Cemophora coccinea</i>	scarlet snake
<i>Elaphe guttata</i>	corn snake
<i>Lampropeltis triangulum</i>	milk snake

Birds

<i>Haliaeetus leucocephalus</i>	bald eagle
<i>Accipiter cooperii</i>	Cooper's hawk
<i>Buteo platypterus</i>	broad-winged hawk
<i>Asio otus</i>	long-eared owl
<i>Melanerpes erythrocephalus</i>	red-headed woodpecker
<i>Certhia americana</i>	brown creeper
<i>Hylocichla mustelina</i>	wood thrush
<i>Wilsonia citrina</i>	hooded warbler

Coastal Plain Upland Forests (Tier 2 SGCN)

Gastropods

<i>Discus catskillensis</i>	angular disc
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Insects

<i>Cicindela patruela</i>	Northern barrens tiger beetle
<i>Cicindela unipunctata</i>	one-spotted tiger beetle
<i>Photuris frontalis</i>	a firefly
<i>Erynnis martialis</i>	mottled duskywing
<i>Erynnis baptisiae</i>	wild indigo duskywing

<i>Battus philenor</i>	pipevine swallowtail
<i>Polygonia progne</i>	gray comma
<i>Caripeta aretaria</i>	a geometer moth
<i>Tolype notialis</i>	a lasiocampid moth
<i>Hemileuca maia maia</i>	the buckmoth
<i>Cisthene kentuckiensis</i>	Kentucky lichen moth
<i>Cisthene tenuifascia</i>	a lichen moth
<i>Grammia phyllira phyllira</i>	tiger moth
<i>Zale metata</i>	a noctuid moth
<i>Catocala flebilis</i>	mournful underwing
<i>Catocala residua</i>	residua underwing
<i>Catocala cerogama</i>	yellow banded underwing
<i>Acronicta exilis</i>	exiled dagger moth
<i>Acronicta lithospila</i>	streaked dagger moth
<i>Papaipema araliae</i>	aralia shoot borer moth
<i>Papaipema baptisiae</i>	wild indigo borer moth
<i>Lepipolys perscripta</i>	a noctuid moth

Reptiles

<i>Scincella lateralis</i>	ground skink
<i>Heterodon platirhinos</i>	Eastern hognose snake
<i>Lampropeltis getula</i>	common kingsnake
<i>Storeria occipitomaculata</i>	redbelly snake
<i>Virginia valeriae</i>	smooth earth snake
<i>Agkistrodon contortrix</i>	copperhead

Birds

<i>Coragyps atratus</i>	black vulture
<i>Strix varia</i>	barred owl
<i>Caprimulgus vociferus</i>	whip-poor-will
<i>Colaptes auratus</i>	Northern flicker
<i>Myiarchus crinitus</i>	great crested flycatcher
<i>Sitta pusilla</i>	brown-headed nuthatch
<i>Vireo flavifrons</i>	yellow-throated vireo
<i>Dendroica dominica</i>	yellow-throated warbler
<i>Mniotilta varia</i>	black-and-white warbler
<i>Seiurus motacilla</i>	Louisiana waterthrush
<i>Oporornis formosus</i>	Kentucky warbler
<i>Piranga olivacea</i>	scarlet tanager
<i>Pipilo erythrophthalmus</i>	Eastern towhee
<i>Icterus galbula</i>	Baltimore oriole

Mammals

<i>Lasionycteris noctivagans</i>	silver-haired bat
<i>Lasiurus borealis</i>	Eastern red bat
<i>Lasiurus cinereus</i>	hoary bat
<i>Canis latrans</i>	coyote

Appendix B: Draft Translocation Plan for the Delmarva Fox Squirrel in Delaware

1. Background and Need

The goal of the Delaware Delmarva Fox Squirrel Conservation Plan (Plan) is to protect and enhance populations of Delmarva fox squirrel (DFS, squirrel) on forested lands in Sussex County, Delaware in ways that do not adversely affect, but have the potential to provide benefits both to the species and the residents of Sussex County. The intent of the Plan is to propose a conservation strategy that results in an increase in the number and distribution of DFS in Sussex County while eliminating potential regulatory burdens on owners of forested land posed by the presence of this species. In order to increase the amount of DFS-occupied habitat in Sussex County, translocations from source populations in Maryland will be necessary.

2. Approach Summary

This Translocation Plan is based on the Release Protocol published in the revised Recovery Plan (USFWS 1993) and has been updated and detailed specifically for this effort through meetings and communications with technical experts.

For each translocation, 24-30 squirrels (with minimum of 12 females) will be translocated from Maryland with the cooperation and assistance of the Maryland Department of Natural Resources (DNR). For each site, some of the squirrels will be moved in the spring, the remainder in the fall. Squirrels will be moved during the seasons/times as recommended by experts in translocations. All squirrels will be received by Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Fish and Wildlife (DFW) and placed on targeted protected lands in Delaware. Specific locations will be identified and monitoring will be conducted by the DFW and experienced conservation partners. All appropriate protocols will be followed. For connectivity purposes, surrounding and adjacent landowners will be encouraged to participate in a voluntary program to conserve habitat for the squirrels. The first translocation site will be in a location to be determined with collaboration between the DFW and the entity receiving squirrels. Subsequent translocations and protocols may be adjusted based on the success of the first translocation.

3. Translocation Planning, Monitoring and Success Criteria

The DFW will establish one new population, monitor results for a minimum of one year and then establish a second new population. The DFW will monitor translocated squirrels yearly for

the first three years post-translocation and periodically for ten years post-translocation. A draft step by step strategy is provided below. All activities will be contingent on DFS being federally delisted and on available funding.

➤ **Prior to Translocation**

- Determine study design to estimate population sizes and home ranges at known sites and a study to determine success of translocated populations.
- *Prime Hook National Wildlife Refuge (NWR) and Nanticoke Wildlife Area (WA):* Monitor existing populations to determine baseline population size. Set up photomonitoring grid and determine trapping schedule.
- Write a specific plan and Memorandum of Understanding (MOU) with Maryland DNR to supply squirrels for translocations.
- *Potential translocation sites* – Conduct GIS review of potential sites and visit most promising sites. Conduct on-site assessments using the Habitat Suitability Index (HSI) model and general visual surveys. Choose specific woodlots for translocations based on those evaluations.
 - Set up a photomonitoring grid and collect at least one year of pre-translocation photomonitoring to ensure DFS are not present and to use as baseline for post-translocation monitoring.
 - Initiate communication with surrounding or adjacent landowners to discuss the Translocation Plan and determine their willingness to report sightings of DFS on their properties. Provide copies of DFS Conservation Plan and DFS-Friendly Practices. Describe the telemetry project.

➤ **Translocations** –The first translocation will take place after DFS are removed from the federal endangered species list and funding and permits have been secured.

- The DFW will release and monitor movements of 24 to 30 DFS, with at least 12 females (more is better) at the first selected translocation site (*location to be determined*). Some animals will be released in the spring and some in the fall. Proportions will be determined during the year of release and will be dependent on environmental conditions.
- **Monitoring success of translocations (short term)** - Monitor the first release of squirrels using telemetry (for at least the first year), followed by trapping and photomonitoring for three to five years post-translocation (funding-dependent). Possibly supplement squirrels after first year if needed.
- Continue to monitor existing populations at Prime Hook NWR and Nanticoke WA and determine if supplement is needed.
- Determine short-term success of first translocation according to the criteria below before beginning the second translocation. Attention should be paid to success of gender to help inform best sex ratios for subsequent translocations.

- If first translocation meets success criteria, perform the second translocation.
- **Monitoring success of translocations (long term)** - Conduct surveys at all DFS sites (existing and translocated) every two to three years when funding is available for a minimum of ten years. Surveys may be conducted more often if signs of decline are noted.

Translocation Success Criteria (short-term)

There will probably be an initial decline in population numbers due to mortality caused by the stress of the translocation as well as mortality associated with trying to acclimate to unfamiliar territory. Squirrels will be monitored with a combination of trapping and photomonitoring.

Translocations will be considered initially successful three years after release if:

- One or more lactating females and at least one other adult are captured on the area, **or**
- Two or more juveniles and at least one other adult are captured on the area, **or**
- If no squirrels were present at the release site, success can be measured by untagged DFS.

Translocation Success Criteria (long-term)

In addition to short term success criteria, translocations will be considered successful when:

- Ten years after translocations numbers of DFS are continuing to increase.
- Reproduction can be confirmed (either by capturing lactating females or young).
- Survival of juveniles (new unmarked adults) can be documented.

Mortality Rates and Supplemental Release

Past translocation efforts with Maryland DFS populations have had high (~ 36 percent) mortality rates within the first 90 days post release. There is high probability that there will be squirrel mortality due to translocation efforts in Delaware as well. Spring releases tend to have higher mortality rates than fall releases (possibly due to food availability). The Recovery Plan (USFWS 1993) recommends supplementing previous translocations that have small (< 24 individuals) populations. Thus additional supplemental releases of DFS may be necessary for existing populations and any of the translocated populations in Delaware.

Delmarva Fox Squirrel Translocation Site Selection

- Release site should have sufficient acreage of appropriate habitat on-site or contiguous with the site to support a viable DFS population. Results of a recent population viability analysis model (Hilderbrand et al. 2004) suggest an area containing 435 acres of suitable habitat (the area does not have to be one piece, but has to be connected to other forest blocks) are needed to secure a population for a minimum of 100 years.

Release site should have a high proportion of trees 12 inch or greater Diameter at Breast Height (DBH) and should be sufficient in number to create a closed canopy.

- Release site should be located in an area that allows for dispersal beyond the original release site to accommodate an expanding population.
- Release site should score above average on DFS HSI habitat model. A large number of large DBH trees and a high, closed canopy are the best determinants of habitat suitability for DFS (C. Keller and G. Therres pers. comm. 2013).
- Release site should be protected from incompatible habitat alterations (timber harvests that remove large portions of habitat or inhibit dispersal, forest removal for development, forest removal for agricultural fields) for a period of at least 20 years.
- Access for release and monitoring purposes must be guaranteed by the landowner (MOU must be in place prior to translocation).
- It is important to release animals in sites that have similar habitat as source habitat where animals were trapped (i.e. hardwoods to hardwoods, pine to pine).

Appendix C: Potential Partners and Programs for Land Conservation/Delmarva Fox Squirrel Habitat Protection

Delaware Farmland Preservation Program – Delaware’s farmland preservation program was created in 1991 and has two tiers: Agricultural Preservation Districts and Agricultural Conservation Easements. Landowners apply to the Delaware Agricultural Lands Preservation Foundation (DALPF) for district agreements and easements. Agricultural Preservation Districts are a voluntary agreement to use land only for agricultural purposes for at least a ten year period. Land must yield a minimum farm income, satisfy a scoring system standard, and undergo a review and approval process. There is no payment to the landowner for creating the district.

In order to permanently preserve farmland, the Foundation purchases development rights from landowners and imposes a permanent Agricultural Conservation Easement on the land. Land must first be in an Agricultural Preservation District before the owner can apply to sell the development rights. Landowners make offers to DALPF for their development rights and DALPF selects easements to purchase based on the percentage discount the landowner offers below the appraised development rights value.

The acquisition of Agricultural Conservation Easements and Forestland Preservation Easements are conducted on a coordinated basis by DALPF. Landowners can have their land in both an Agricultural Preservation District and a Forestland Preservation Area and are entitled to submit separate offers to sell easements.

Forestland Preservation Program – The Forestland Preservation Program is modeled after the Farmland Preservation Program. The Forestland Preservation Program has two tiers (Forestland Preservation Area Agreement and Forestland Preservation Easements) and landowners apply to DALPF for area agreements and easements.

Forestland Preservation Area Agreements are voluntary ten year agreements to follow particular forestland management practices. Having a Forestland Preservation Area Agreement makes a landowner eligible to apply for an easement. This program is designed to protect working forests; therefore, the easements allow forest management activities, including timber harvests, to continue. Landowners can harvest timber at any time on their property as long as they follow a forest management plan prepared by a professional forester.

The ranking criteria for Forestland Preservation Easements are based on four factors: 1) forest productivity; 2) percentage of discount provided by the owner from the appraised value of the Forestland Preservation Easement; 3) location within a State Resource Area; and 4) location within a State-designated Natural Area.

The Forestland Preservation Program went through their first round of applications for easements in 2008. Between the State and The Nature Conservancy funding, 9 easements have been established protecting a total of 835 acres.

Delaware Forest Legacy Program – The Forest Legacy Program is a national program of the U.S. Forest Service that is administered in Delaware by the Department of Agriculture's Forest Service. The program is designed to protect private forest lands from conversion to non-forest uses through property acquisition or by acquiring conservation easements. The program is available only in areas identified in Delaware's Forest Legacy Assessment of Need (AON). Delaware's AON was approved in 1998 and there are four legacy areas in Delaware: White Clay Creek, Blackbird/Blackiston, Redden/Ellendale, and Cypress Swamp.

In 2004, the Forest Legacy Program obtained an easement on 908-acres of land owned by The Nature Conservancy within the Redden/Ellendale Legacy Area. Between 2005 and 2008, the Program purchased by fee simple 1,124 acres of land that have become part of the protected Redden State Forest (also within the Redden/Ellendale Legacy Area).

Private Lands Assistance Program – The Private Lands Assistance Program is administered by DNREC Division of Fish and Wildlife. The program offers private landowners technical and financial incentives to protect, enhance, and/or restore habitat to benefit species-at-risk.

Delaware Ecological Network – The Delaware Ecological Network (DEN) is a statewide conservation network developed from GIS and field-collected data. The DEN, based on principles of landscape ecology and conservation biology, provides a consistent framework to help identify and prioritize areas for natural resource protection. The DEN is composed of the following elements: core areas, which contain relatively intact natural ecosystems, and provide high-quality habitat for native plants and animals; hubs, which are slightly fragmented aggregations of core areas, plus contiguous natural cover; and corridors, which link core areas together, allowing wildlife movement and seed and pollen transfer between them. Mapping done for this project can be integrated with DEN mapping to help inform prioritization decisions.

Delaware Bayshore Initiative - Although not directly related to DFS conservation, areas within the Delaware Bayshore have the potential to support DFS. The Delaware Bayshore Initiative plans to collaboratively build on the region's reputation as a unique and beautiful natural resource, and help improve the shoreline economy by encouraging more Delawareans and visitors to enjoy it through activities such as recreational fishing, hunting, boating and ecotourism. This non-regulatory approach will continue the tradition of DNREC's commitment to preserving the state's coastal zone, which has been protected by Delaware's Coastal Zone Act for the past 40 years. Due in large part to the legacy of that landmark legislation, more than half of the Delaware Bayshore's acreage remains undeveloped, and is today protected as state or Federal wildlife lands.

Delaware Greenways – Delaware Greenways is a statewide nonprofit organization committed to the preservation and enhancement of Delaware's natural, scenic, historic, cultural and recreational resources.

Delaware Nature Society (DNS) – DNS is a non-profit organization involved in environmental education, natural resource conservation and preservation, and advocacy. The organization

manages over 1,000 acres of land statewide and has protected more than 480 acres through conservation easements and deed restrictions.

Nanticoke River Watershed Conservancy – The Land Trust Alliance website indicates that the Conservancy owns 75 acres and has easements on 325 acres in Delaware.

The Natural Resources Conservation Service (NRCS) – A program that is part of the U.S. Department of Agriculture, NRCS's natural resource conservation programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat and reduce damages caused by floods and other natural disasters. The NRCS in Delaware administers a broad range of programs to assist landowners and communities with conserving and protecting natural resources. Their conservation programs are voluntary and provide technical and payment assistance for the planning and implementation of conservation systems. They also administer several easement programs and grant programs aimed at collaborative conservation efforts.

North American Land Trust (NALT) – The Land Trust Alliance website indicates that the NALT has 2 acres under easements in Delaware.

Sussex County Land Trust (SCLT) – The land trust was formed in December 2001 by two local developers that wished to encourage smart growth principals. According to their website, they protect land in and around Sussex County through donations of conservation easements and have been involved in preserving 5,784 acres.

The Nature Conservancy (TNC) – TNC is involved in land protection work in Sussex County, Delaware. For example, TNC owns the Pemberton Forest Preserve which covers 1,364 acres in Sussex County and is less than 5 miles from a DFS site.

Other Partners Include:

- USFWS Chesapeake Bay Field Office, NWRs, DE Estuary Program Office
- Department of Agriculture – Delaware Forest Service
- DNREC – Land Use, Delaware Division of Parks and Recreation
- Delaware Coastal Program
- Forest Legacy Program, Delaware Forest Service
- Sussex County Planning and Zoning
- Center for the Inland Bays
- Sussex County Land Trust
- Delaware Nature Society
- The Nature Conservancy, Delaware Field Office
- The Conservation Fund
- Delaware Wild Lands, Inc.
- Environmental Defense
- Universities
- Positive Growth Alliance
- Sediment Control and Stormwater Management Program, DNREC
- Environmentally Sensitive Areas Certified Construction Review Program in Sussex County

- Amelia Wright, Otis Clifton, Delaware Landowners
- Maryland Department of Natural Resources
- Maryland Forest Service

**Appendix D: Summary of the Timber Volumes for Redden State Forest
by Species and Age Class by Tract.
(Provided by Delaware Forest Service, November 2013)**

Appenzellar Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	6	24.7						0
Lob.Pine	16-25								
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40	5	16.2	222,576					222,576
Pine/hdwd	56+	3,4	68.3	209,380	118,910	68,511	147,188	54,386	598,375
Hardwood	56+	2	49.1	28,326	110,915	68,237	158,365	14,275	280,118
Reserved		1(seed orchard), 7	21.5						
Wildlife		8	3.4						
Agriculture									
Bailey Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15								
Lob.Pine	16-25	4,6	88.8						0
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55	3	43.2	484,814	17,473	3,046	93,588	8,361	607,282
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+	2,5	208.3	1,218,649	34,359	382,050	1,003,114	5,920	2,644,092
Hardwood	56+	1	66.1	37,481	16,734	51,159	473,788		579,162
Reserved									
Wildlife									
Agriculture									

Barr Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	2,3	56.8						
Lob.Pine	16-25								
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+	1	83.5	210,503	4,593	52,605	642,282	3,841	913,824
Reserved									
Wildlife									
Agriculture									
Chesapeake Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	3,13,16,19	198.3						0
Lob.Pine	16-25	4,7,9,10,11,12 15,17,18	335.5						0
Lob.Pine	26-35	1,2,5,6,14	285.9						0
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40	8,20	148.1						0
Pine/hdwd	56+								
Hardwood	56+								
Reserved									
Wildlife									
Agriculture									
Collins Pond Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	1	37.5	0					0
Lob.Pine	16-25								
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+								
Reserved		2	7.5				0		0
Wildlife									
Agriculture									

Day Tract									
Type	Age Class	Stand	Acreeage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15								
Lob.Pine	16-25								
Lob.Pine	26-35								
Lob.Pine	36-45	1	181.7	1,676,098					1,676,098
Lob.Pine	46-55								
Lob.Pine	56+	2	31.3	710,754			27,243		737,997
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+								
Reserved		3,4	38.9						
Wildlife									
Agriculture									
Deep Creek Tract									
Type	Age Class	Stand	Acreeage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	7	68.6						
Lob.Pine	16-25	5,6	141.3						
Lob.Pine	26-35	3,4	39.7						
Lob.Pine	36-45	1	190						
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+								
Reserved		2,8	128.6	15,944	58,597	22,862	684,064		781,467
Wildlife									
Agriculture									
Ellendale Tract									
Type	Age Class	Stand		Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	12,15,22,23,24,26	580.2						0
Lob.Pine	16-25	16,17,18,19,20,21	293.8						0
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	50-55	1, 2	101	340,986	254,919	96,271	98,271	128,467	918,914
Pine/hdwd	56+	5,6,7,8,9,11,13,14	450.1	1,463,686	224,516	606,327	1,323,127	107,643	3,725,299
Hardwood	56+	3, 4, 10	60.8	44,586	58,775	105,409	204,772	23,576	437,118
Reserved		14,25	231.9	76,780	38,814	402,010	967,495	27,771	1,512,870
Wildlife		27	12.1						

Headquarters Tract (including Eskridge)									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	2,4,5,7,10,14,15, 21,33,34,36	314						
Lob.Pine	16-25	23,24,25,26,27, 28,29,30,31,38,39	330.3						
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+	3,6,8,9,12,19,22	415.5	3,284,595	262,660	72,693	426,888	14,391	4,061,227
Pine/hdwd	0-35	37	84.9						
Pine/hdwd	56+	11,35,40	94	293,731	48,906	71,797	80,795	70,829	566,058
Hardwood	56+	2	39.4			27,649	179,568		207,217
Reserved		1,13,16,17 18,20, 32	654.3	2,026,602	452,242	85,961	885,386	219,414	3,669,605
Wildlife		41	25						
Jester Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	19,28,29,30,50,52,54	259.3	0					0
Lob.Pine	16-25	3,14,23,39,40	220.6	0					0
Lob.Pine	26-35	5,22,24,25,26 27,47,48,53	294.2	0					0
Lob.Pine	36-45	32	5.6	37,003					37,003
Lob.Pine	46-55	4,49	51	627,403			15,420	12,068	654,891
Lob.Pine	56+	15,18,20,35,38,43,45	203.7	2,919,361	33,467	30,201	304,404	41,816	3,329,249
Pine/hdwd	0-35	-----	0						0
Pine/hdwd	56+	10,11,12,13,16,31 36,42,51	422.8	2,204,961	300,066	416,006	871,569	600,629	4,393,231
Hardwood	56+	33,37	86	136,750	124,620	261,992	104,867		628,229
Reserved		1,2,6,7,8,9,17,21 34,41,44,46	526.4	1,622,867	720,280	595,858	1,131,621	399,779	4,470,405
Wildlife		52	20.1	0					
Long Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	2,3,4	194.3						0
Lob.Pine	16-25								
Lob.Pine	26-35	1	47.8						0
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+								
Reserved									
Wildlife									
Agriculture									

Owens Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	4	39.6						0
Lob.Pine	16-25								
Lob.Pine	26-35	1	51.2	260,243			7,744		267,987
Lob.Pine	36-45	3	44.8						0
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+	2	124	21,743	75,261	483,859	644,231	20,042	1,245,136
Reserved									
Wildlife									
Agriculture									
Rayne Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15								
Lob.Pine	16-25	3	27.4						0
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+	1	43.7	912,595			70,607	2,835	986,037
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+	2	34.2				456,033		456,033
Reserved									
Wildlife									
Agriculture									
Sill Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	1,2,3	93.1						0
Lob.Pine	16-25								
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+								
Reserved									
Wildlife									
Agriculture									

J.G. Townsend Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	4,6,7,8,11,12	395						
Lob.Pine	16-25								
Lob.Pine	26-35	2,10	169.1	753,863	41,397	7,698			802,958
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-35	5	4.1						
Pine/hdwd	56+	1,3	199.2	815,940	192,558	120,205	421,442	97,175	1,647,320
Hardwood	56+								
Reserved									
Wildlife		13	24.9						
Agriculture		14	125.6						
Tunnell Tract									
Type	Age Class	Stand	Acreage	Loblolly Pine	Red Oak	White Oak	Other Hardwoods	Other Softwoods	Total
Lob.Pine	0-15	1,2,5,6	513						0
Lob.Pine	16-25	4	167.3						0
Lob.Pine	26-35								
Lob.Pine	36-45								
Lob.Pine	46-55								
Lob.Pine	56+								
Pine/hdwd	0-40								
Pine/hdwd	56+								
Hardwood	56+								
Reserved		3,7	139.8		64,028	24,981	696,702		785,711
Wildlife									
Agriculture									
	Total		10,781.4	22,834,898	3,254,090	4,057,387	12,120,574	1,867,171	44,134,120